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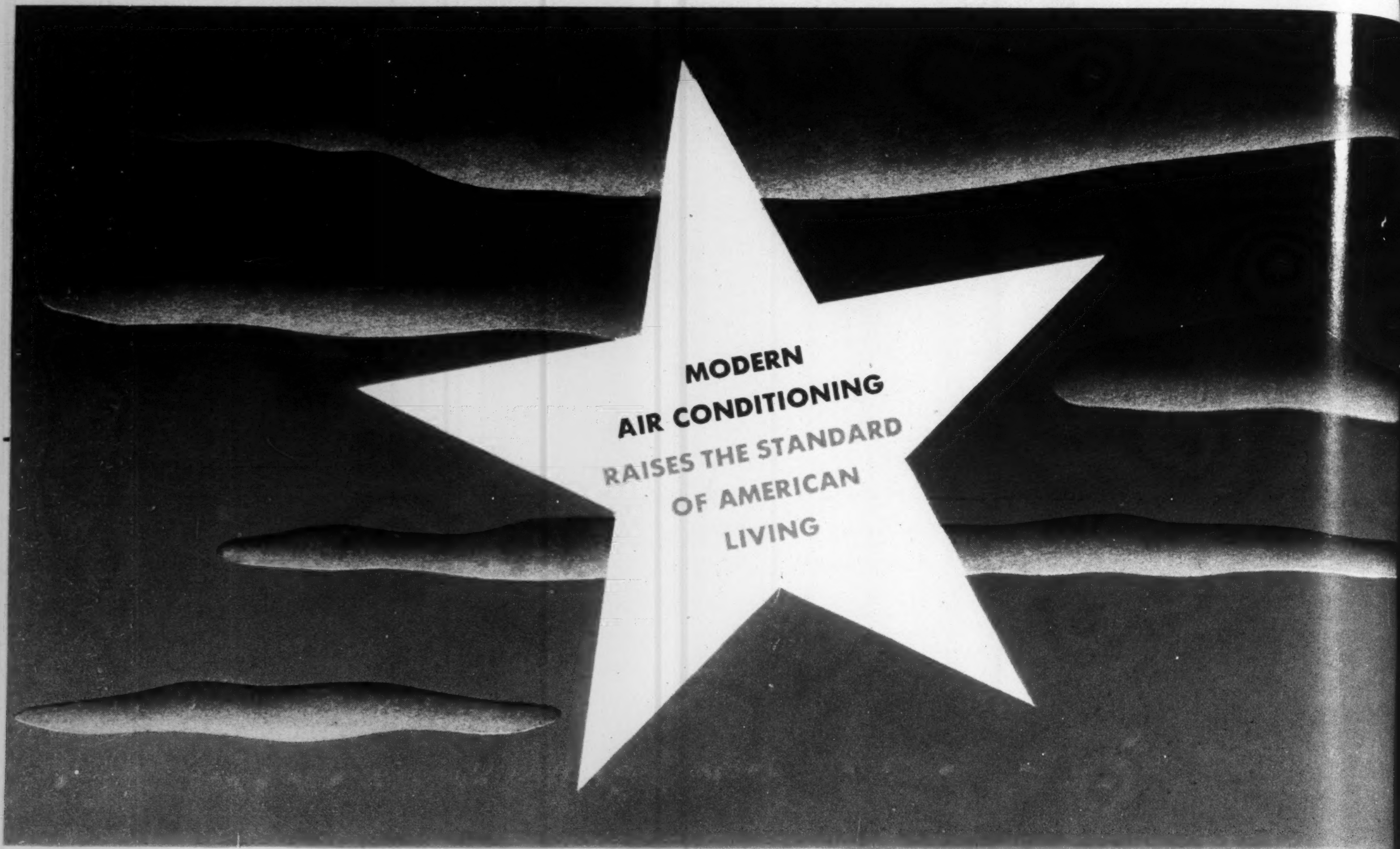
## in America - *THE FIGHT IS FOR NEW IDEAS - SKILLFULLY APPL*



## JOHNSON CONTROL...*The "BRAIN" of Air Conditioning*

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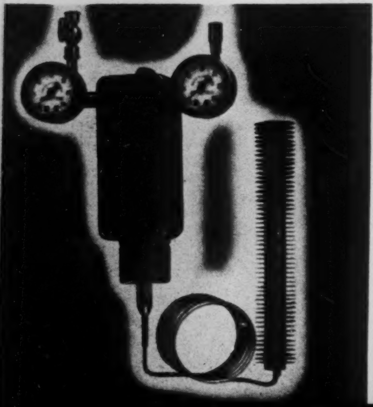
The American way to better living is exemplified by the desire of American industry to provide more diversified services, additional conveniences, and greater comforts for all. Institutions which live by serving the public are aware of the business-getting value of modern air conditioning. In countless of these air conditioning installations, Johnson automatic temperature and humidity control supplies the "brainwork" . . . Never-ceasing research and design, for greater economy and efficiency in the automatic operation of air conditioning plants, places the nation-wide Johnson organization in the front rank of this march of progress.



One of the Johnson line of Extended Tube Thermostats. Various types of bulbs adapted to a variety of uses in automatic air conditioning control.

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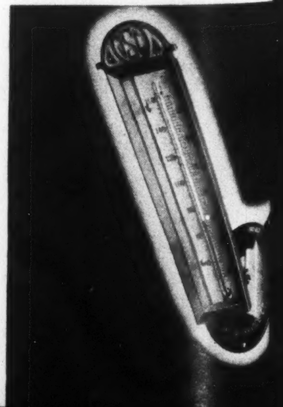
Efficient devices are valuable only if they function perfectly as part of the whole. Consequently, Johnson stresses the importance of complete control systems, designs, manufactures, installs, and services its own installations. A nation-wide organization stands ready to supply information on installing new or rehabilitating existing systems of automatic control. There is no obligation. Johnson Service Company, Milwaukee, Wisconsin. Direct Branches in Principal Cities.



Johnson "Sunrise" Insertion Thermome with unique adjustable tilting featu Full 9-inch scale and red-reading me cury column in heavy lens glass tub

**JOHNSON**

*Automatic* TEMPERATURE AND AIR CONDITIONING *Control*

# Heating·Piping and Air Conditioning

*with which is merged the "Aerologist"*

**Design, Installation**
**Operation, Maintenance**
**in Industry and Large Buildings**

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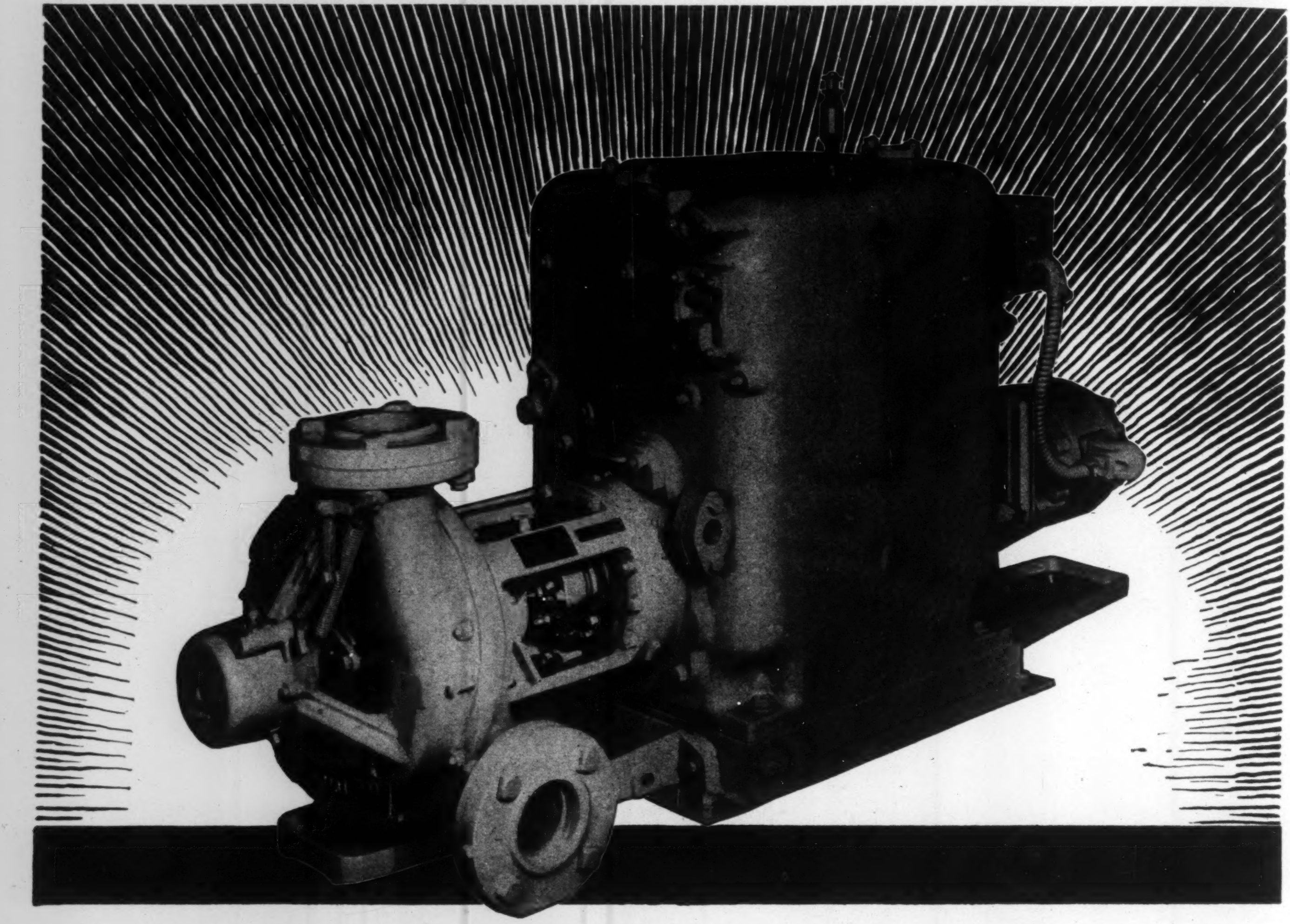
# Safety!

## THE NASH VAPOR TURBINE HEATING PUMP IS NOT STOPPED BY ELECTRIC CURRENT FAILURE



For service in greenhouses, hospitals, schools, theatres, and public buildings, where heat failure is a serious matter, the Nash Vapor Turbine Return Line Vacuum Heating pump should be specified, for this pump operates perfectly without electric current.

This is because the motive power is a special turbine operating on steam direct from the heating system. Steam used to drive the Vapor Turbine is returned to the system for heating, with little heat loss.

This pump insures constant heat in the system, it eliminates electric current cost, and it promotes high efficiency in the heating system. Heating efficiency is due to the fact that this pump can operate continuously with economy. Continuous operation means uniform circulation, and uniform conditions in the system mean steam saving.

This pump has but one moving part, no internal wearing parts, and requires no internal lubrication. Bulletin D-246 tells all about it, and it is free on request.

**THE NASH ENGINEERING COMPANY**

**SOUTH NORWALK, CONNECTICUT, U. S. A.**

# THE EDITOR'S PAGES

## *WASHINGTON CORRESPONDENT REPORTS ON PROGRESS OF NATIONAL DEFENSE CONSTRUCTION TO DATE*

*Out of the welter of official Washington, Arnold Kruckman, Washington correspondent, has prepared especially for* Heating, Piping and Air Conditioning *the following summary of the national defense construction program to date. So many offices and agencies issue some information, so much other information is buried in inaccessible places or is deliberately unavailable, so many developments come daily, that the task of arriving at the correct figures is almost insurmountable. Mr. Kruckman's story is intended to give a picture of the national defense construction program slanted particularly for those whose interests are in the heating, piping and air conditioning services required in these new plants and buildings.*—The Editor.

Since July 1, the beginning of this fiscal year, and ending with the last week in September, government contracts and awards announced for building and construction for national defense total $832,470,712, it appears; this roughly approximates the forecast for the year. Those who should know believe we will spend about $6,000,000,000 on building and construction for national defense during the fiscal year of July 1, 1940, to June 30, 1941. The usual normal industrial and private construction program should be regarded as additional; last year it amounted to something like $4,000,000,000.

No one yet knows exactly how many military camps and posts will be built new from the ground up, and how many existing posts will be expanded. They tell you the information is restricted because it is a military secret; but the real reason, in the majority of cases, appears to be to prevent the information from reaching local community organizations and others who might profiteer on the tip.

Under normal circumstances the federal government spends about 6 per cent of its building budget for piping, including everything from cast iron to brass and copper pipe, the percentage covering purely the cost of the pipe, not installation nor labor. It spends about the same percentage on heating installations, also minus labor, which usually are steam or hot water. The figures are derived from reports from contractors.

The government very rarely contracts directly for the heating, piping, plumbing and similar installations and the same custom prevails in practically all national defense work. The general contractor is employed on a cost-plus-a-fixed-fee basis, and he is regarded as the agent of the government empowered to hire and purchase all service and every installation that goes into the structures included in his contract. He is required, however, to secure approval of every bargain he makes, and gets this okay from the army or navy inspector. Under existing circumstances the rush to build is so great that the plans issue from the engineers' and architects' offices in Washington piecemeal, and are so sketchy that it is almost impossible for the Washington office even to consider the subcontracts. The job is necessarily almost wholly under the control of the general contractor. Apparently the place to sell him piping and heating installations and service is at the point of the project.

Each air conditioning installation is unique in itself. For instance, air conditioning is specified in the hospital to be built at Moffett Field, Calif., and at the hospital at Orlando, Fla., the sum of $129,300 being specified in the schedule. The plant to manufacture TNT and DNT, at Wilmington, Ill., to be built by Stone & Webster for $10,863,000, is to be air conditioned. There are a number of gun plants to be operated by the army which require air conditioning. Air conditioning also is specified in several new arsenals, and in the great powder plants in Ohio and Virginia which will cost over $40,000,000. There are also hospitals with special air conditioning scheduled at Jacksonville, Quantico, San Juan, Guantanamo and Coco Solo; over a million is indicated for piping and air conditioning in the naval hospital at Washington, D. C.

Air conditioning is specified for the new navy hospital to go up at Chelsea, Mass., and at Camp Custer, Mich. The sum of $492,800 is indicated for air conditioning and piping. Hospitals will be erected at all the camps, and at many of the posts which are to be expanded, and air conditioning will be installed at each place. One of the outstanding air conditioning jobs will be the $92,000,000 plant to be erected at Hamilton, Ohio. Over 12,000,000 sq ft of floor space is to be added to other airplane factories in the near future, and each factory will require air conditioning in some of its departments. Air conditioning also is specified in the plans for the expansion of some of the new plants at Scott Field, Belleville, Ill., and is indicated in the shops at other army air fields. It is expected the great air depot of the army at Stockton, Calif., will have a number of buildings to be variously air conditioned. An army hospital in the west is scheduled for an item of $129,300 worth of air conditioning. The General Motors plants, for which the government has advanced $62,000,000, will include air conditioning.

Piping on a large scale is planned for Camp Custer, Mich., $126,800 being set aside for the purpose. In a naval hospital $10,747 is allocated to special piping. Both piping and air conditioning are specified at Carlisle Barracks, Penn.; and $203,748 worth of piping is required at the navy yard in Pearl Harbor, Hawaii. Special piping is specified at MacDill Field, Tampa, Fla., and at various new camps. Much special piping is indicated at the camps where the national army begins its year's service in tents. Over $50,000 for piping is programmed at Ft. Niagara, and a large expenditure is indicated at Ft. Jackson, S. C. At a fleet base, which will cost $18,012,500, a special item of $665,000 is specified for heating and piping. The Stockton air depot is to have a water distributing system which will cost $55,000. Hill Field, in Utah, will have $130,000 of piping.

The airport program, for which congress has made a special appropriation, starts with 75 fields for military use which will be built immediately, and includes 3400 more which will be built as rapidly as the work may be thrown into gear. Within the next three or four years this program envisions the creation of a total of 4000 airports in all parts of the country; the plan is to place one airport within 30 minutes of every town and city. Each airport involves special and extensive piping. Some will have shops that will be air conditioned. The work on these airports is jointly directed by the army, the navy and the civil aeronautics authority, with the coöperation of the localities where each airport is built.

In Washington the interests of the piping and heating industries focus in a manufacturers liaison committee headed by George Hoffman. In the quartermaster general's office, the industries maintain liaison through Major F. S. Harvey, chairman of the advisory council of the construction division of the army. Major Harvey lists the contractors who are found to be qualified to do the national defense work. The general supervision of building activities comes under L. M. Leisenring, supervising architect of the quartermaster general's construction division; and heating, piping and air conditioning comes directly under the control of John R. Gramm, mechanical engineer in charge of the interior utilities section. The expert immediately in charge is A. L. Sherman. In the navy the liaison officer for the industries is Commander W. B. Young of the procurement section of the bureau of supplies and accounts. Much of the work comes jointly under the supervision of the army, navy and the procurement division of the treasury department. The procurement division often works on the assignment of the national defense advisory commission. Many of the problems of selection, and the details of contracts, are handled by the procurement division, particularly if they are special jobs that are directly ordered for the government from the industry immediately concerned. The expert in the procurement division in charge of heating, piping and air conditioning is G. C. Salomone, senior purchasing officer.

Practically all national defense business is placed with contractors or manufacturers on the basis of cost-plus-a-fixed-fee, a system to hurdle the bid-advertising delays. Under this system the seller is paid all costs of materials, services, labor, transportation, overhead, etc., and in addition receives a fixed fee, the fee being determined by agreement. In lieu of invitation bids, the contractor or manufacturer is chosen from the list of 3000 or more assembled by Major Harvey. Three names are usually suggested and are approved by the so-called Hogan committee, an organization which acts for the army, navy and other national defense agencies. The Hogan committee consists of representatives of the associated general contractors of America, the several architectural societies, engineering associations, the construction league, and similar national organizations. Either all or any one of the firms chosen by this committee receive the job; or on occasion the choice is made directly by the government agency itself.

## INDUSTRY EXPANDS FOR DEFENSE WORK

Expanding peacetime and preparedness activity is reflected in the announcement by President George H. Bucher that August, 1940, was the biggest month in the history of the Westinghouse Electric & Mfg. Co. August's business showed a 68.8 per cent increase over July and business for the first eight months in 1940 a 67.1 per cent increase over the same 1939 period. Employment approached the peak months of 1929 and 1937.

If all emergency orders were eliminated from the monthly report the remaining peacetime business would still be comparable to the best peacetime months in the company's history, it was explained, even when the boom year of 1929 is included. The company's previous record month was October, 1917.

Since last June, Westinghouse has completed five buildings; nine are under construction, and another is contemplated.

* * *

The placing of a $20,000,000 machine gun order with Frigidaire Div., General Motors Corp., announcement of which was made last month, will not interfere with manufacture of the company's regular products, according to a statement issued by E. G. Biechler, general manager.

"The task of providing machine guns for the government will be carried out with the use of additional facilities, including a new five story factory building," Mr. Biechler said. "The regular line of products, therefore, will be manufactured on an uninterrupted schedule in the plants and with the machines ordinarily used for this purpose."

Work on the new building for gun production, which will be erected on a site adjoining existing plant buildings following demolition of an old structure now standing on the property, is to begin immediately. The building is to be ready and machinery is scheduled to be installed before gun production tools and dies are completed. Actual gun manufacturing is expected to begin in about 10 to 12 months.

## HOUSING FOR DEFENSE WORKERS

Private industry has the capacity to provide the major part of the housing needs of our defense program, but immediate action is necessary if the delays and mistakes that crippled America's war effort in 1917-1918 are to be avoided. This finding is included in a special research report prepared for the housing committee of the Twentieth Century Fund, the first section of which was made public last month.

According to the research staff, in only a comparatively few places did the ordinary supply of housing break down sufficiently in 1917-1918 to create a necessity for direct governmental operation. These places were centers of high concentration of war activities where competition for labor and materials was intense, where transportation was overtaxed and where the certainty of a decline in industrial operations after the emergency discouraged private enterprise. While the private building industry faces the present emergency with more favorable circumstances than in 1917-1918, we may still be confronted by many critical situations, according to the report. Industrial expansion has hardly begun, yet the names of many of the trouble centers of the last war are heard again — Newport News, Camden, Quincy, Bath and the arsenal towns.

## PLEDGE ASSISTANCE IN NATIONAL DEFENSE

Manufacturers in the plumbing and heating industries pledged their wholehearted coöperation in the national defense program at a meeting of representatives of various associations and industry groups held in Cleveland last month. Called at the suggestion of the construction division of the advisory commission to the council of national defense, the meeting voted to organize a plumbing and heating industries manufacturers' committee. George E. Hoffman, Crane Co., was elected chairman.

The purpose of the advisory commission in asking for the active coöperation of the plumbing and heating industries was outlined in a statement by J. W. Follin, managing director of the producers' council, who was instrumental in calling the meeting. The primary purpose, he said, is to check the defense requirements with the industries.

"The plumbing and heating industries," Mr. Follin declared, "occupy a very important and strategic position in the defense picture.

"The calling of the national guard and the draft involve large shifts of population. Adequate and sanitary shelter must be made available swiftly.

"The purpose of the advisory commission is twofold. In the first place, the commission wishes to acquaint the plumbing and heating industries with certain initial needs for materials and equipment. In the second place, the commission wishes to ascertain the capacity of the industries for the production of materials.

"The basic objective is to avoid bottlenecks in the production of materials essential to the defense program. A billion dollars worth of construction is involved in appropriations that have already been approved by congress.

"The advisory commission wishes to have everything handled in an orderly way through the normal channels. The commission will acquaint the industries with its needs broken down on the quarter of a year basis. Thus members of the industries will be able to prepare their individual inventories for the total requirements. Manufacturers, knowing in advance the total tonnage involved in requirements, should be able to adjust their inventories so that excess production will be avoided while at the same time adequate stocks will be on hand to fit into the defense requirements."

Heating·Piping
and Air Conditioning

Vol. 12, No. 10 • October, 1940

# Do Piping Improvements Pay?

## The Chief and Gard Work Out a Couple of Charts for Checking Probable Profit on Money Spent for Piping

By A. C. Kirkwood*

SUMMARY

**The Chief and Gard—who Mr. Kirkwood has already introduced to you—have been busy of late analyzing requests from various plant departments for piping improvements and changes. Sometimes they're kept pretty busy determining if a proposed change is or isn't financially sound, so the Chief had Gard work out a couple of charts to simplify the job. . . . The charts are reproduced here. With the first one, knowing the interest rate and the amortization period in years, the amortization in per cent of investment can be found. Then, by knowing the investment required for the piping change and the per cent amortization, the savings and the percentage of profit can be determined. Fig. 1 is self-explanatory, although its use is described in the text, as is the use of Fig. 2. The dotted lines on Fig. 2 are used for the example discussed by Gard and the Chief**

"HELLO, Chief, what's new today?"

"Plenty, Gard, plenty! Ever since we started analyzing requests for piping improvements, the department heads have kept me busy checking their ideas and formal requests for improvements. Not that I mind doing it—I'm interested in cutting production costs and improving equipment availability. But making the calculations and checking them with the department heads and cost accounting, plus discussions with the Boss, takes a lot of my time and yours."

"Well, Chief, I'll help make it easier if I can, but you'll have to give me the details of what you want."

"O. K., Gard. First, we can get production costs and financing charges from cost accounting. Second, we have our own and the various department records on machine availability. Next, we have our records and access to the purchasing department's files on cost of piping materials and labor. But, when we get all these, we must still put them together to get a true picture. That takes time—but more to the point, we must make the picture simple and conclusive so that we can either turn down the request definitely and quickly, or approve it with sufficient emphasis to get the Boss's approval without a lot of unnecessary discussions."

"Right the first time, Chief. But where do I fit in?"

"Well, pictures are the easiest way to tell stories. Graphs or charts are a form of picture. If we can have a chart that will allow us to show the relationship between investment, rate of amortization, amount of amortization, annual savings, and profit (if any), we can save time and do a better job. I notice that Ackerman of Cost Accounting is talking to the Foremen's Club this week. Why don't you ask him for suggestions?"

* * *

What the Chief said is usually a self-evident truth. Figures and prosaic discussion of facts often fail to arouse interest and full appreciation in those who read them. Enliven them with a simple picture in graphical form and interest and appreciation is increased very markedly.

In the case at hand, the problem is one of coördination of several factors of cost and financial procedure to indicate whether or not any proposed improvement under examination will be profitable—and if so, to what extent.

The cost of the proposed changes can be shown as a bill of material and estimate. This should be accompanied by a drawing or sketch showing the extent and location of the changes in plant and equipment. The sketch or drawing should be arranged and drawn to emphasize the new layout, not overlooking essential references to existing facilities, equipment and structures.

Operating costs in terms of the individual machine or unit production are necessary. These should be stated in terms of existing operating conditions, with restatement in terms of conditions subsequent to completion of improvements. Depending upon individual conditions, it may be possible and desirable to portray graphically the comparative costs. On the other hand, this graphical comparison may be of minor value and may serve to distract attention from the important technical pictures of physical changes and financial relationships.

These latter relationships are all-important, in that they show whether or not the proposed improvements are worthwhile and to what extent. A series of calculations and a table of results will clearly define the answer. On the other hand, a simple picture may be of invaluable assistance in interpreting these figures, particularly where they must be discussed with someone not familiar nor fully acquainted with the methods used to arrive at the results.

Each organization has its own method of writing off the cost of capital expenditures. These will vary in many respects, particularly as to amortization period, use of straight line or sinking fund amortization, interest rates, and whether or not interest is computed on amounts transferred to sinking fund. Further, the period of amortization may be different for different departments in accordance with life expectancy determined by experience with equipment served.

---

*Burns & McDonnell Engineering Co., Consulting Engineers.

The curves in Fig. 1 are based upon the sinking fund method, with identical interest rates used for both cost of money and earnings in the sinking fund. Interest rates from one to seven per cent are shown. Amortization periods of two to 30 years are covered, except for rates of one and two per cent.

Entering the sheet at the proper year for the selected amortization period a line projected to the correct interest rate curve will intersect the curve at a percentage value defined as the per cent of investment to be placed annually in the sinking fund in order to pay annual interest and retire the investment at the end of the amortization period. It should be noted that the horizontal scale changes at the five year mark, this being done to increase the legibility of the curves.

With the rate of annual amortization charges determined it is possible to correlate the other major elements of the graphical story. Fig. 2 is a pair of synchronized curve families. Considering first those curves below the horizontal scale it is found that the vertical scale is for dollars invested in the improvement program. The diagonal lines are the per cent amortization obtained in Fig. 1. The horizontal scale shows the investment multiplied by the amortization rate, i. e., it shows the annual amortization in dollars. Note that any rate (per cent) of amortization may be found by interpolation on the bottom line of the chart. The vertical scale is in terms of unit dollars and can be used conveniently for any value of investment.

Entering the chart on the lower vertical scale at the proper amount of investment, a line is projected to its intersection with the previously determined rate of amortization. A vertical line at this point will cross the horizontal scale at the amount of annual amortization.

The upper vertical scale shows the amount of annual amortization and the savings in terms of unit dollars. The horizontal scale is common to both parts of the sheet. The diagonal lines show the per cent profit, i.e., the per cent relation of annual savings in excess of annual amortization to annual amortization.

Continuing with the explanation, the vertical line indicating amount of annual amortization charges is extended to the level of annual savings. Where this line intersects the lowest diagonal line also indicates the level of annual amortization in dollars. Horizontal lines through these points, coupled with the zero level (at the horizontal scale), graphically portray the relationships of annual cost and profit. Where the vertical line of annual amortization crosses the horizontal line of annual savings is a common intersection with a diagonal line showing per cent annual profit.

* * *

"Chief, here are your curves. That man Ackerman not only told me how to make them up; he dropped over to the house last night to check them."

"Good. I suppose they were all laid out correctly?"

"Yes, but he liked them so much he has asked for the original tracing that Joe made up this morning. Wants to put it in the plant tracing file so he can get copies quickly when he needs them."

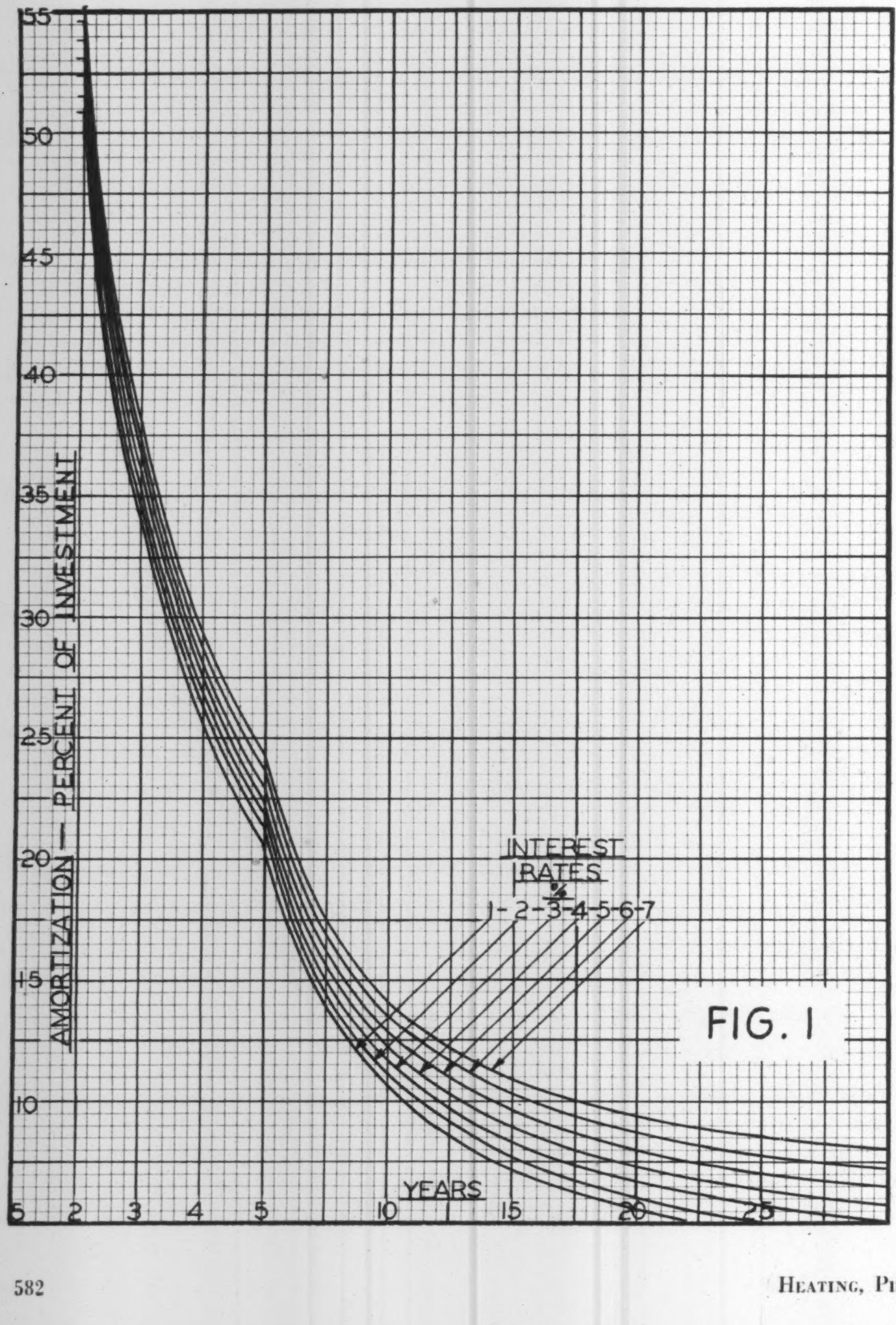
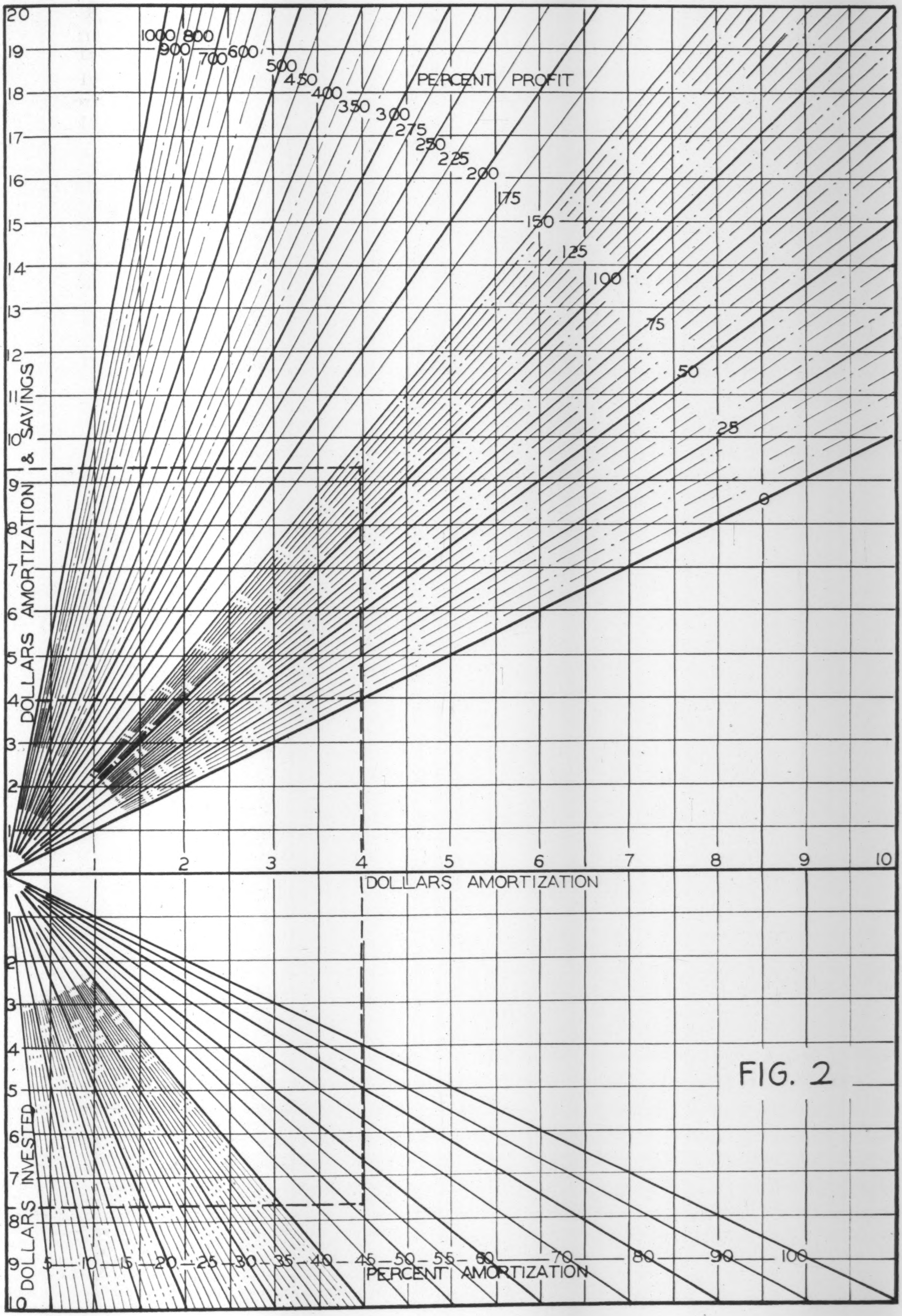


FIG. 1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PERCENT AMORTIZATION

FIG. 2

"All right, Gard. I see you have worked out an analysis."

"Well, it's this way, Chief. Jones, in the moulding department, worked up his ideas of investment and savings. I got Accounting to tell me the proper amortization period and interest rate. If I have the idea right, the story shows up this way. Two year amortization on a 3 per cent basis shows 52.3 per cent rate of annual amortization on Fig. 1. Jones says he figures $770 is the cost of the change and at 52.3 per cent the annual amortization charge is just about $400 from Fig. 2. He claims the improvements will save at least $930 in product value annually based on machine outage records. All right, that shows a profit of $930 minus $400 or $530 per year, or 135 per cent of annual cost on Fig. 2."

"Looks like you have worked it out correctly, Gard. Now check Jones' estimates, make a clear sketch of the new piping and adjacent old piping, and if your own complete analysis is as favorable as this, we'll take this picture to the Boss. I'll buy the cigars if he takes over 30 minutes to approve the request."

# How Animals React to Air Conditions

## Reactions of Animals to Environmental Temperature, Humidity and Air Movement Outlined by Samuel Brody*

THERE are two aspects to air conditioning and ventilation problems: (1) physiologic, concerned with responses and adaptation of animals to their environment, and (2) engineering, concerned with adaptation of the environment to the animal. Our present knowledge of the engineering aspect is far ahead of our knowledge of the physiologic aspect; it is therefore timely to discuss physiologic aspects.

There is a minimum energy cost to being alive which is measured by heat production or heat dissipation and is called "basal metabolism." In addition to this basal metabolism there are heat production increases going under the names of "supermetabolism" or "heat increments" above the basal level. Thus the heat increment of feeding may double the heat production; heat increment of muscular work in horses may increase heat production 10 times (and for very short intervals up to 100 times) that of the basal metabolism. All productive processes, such as milk or egg production, have heat increments, partly because they are associated with increased feed consumption, and partly because there may be an energy expense to "making" the milk, eggs and so on from their precursors.

The heat produced must be dissipated at such a rate as to keep the body temperature constant. In nonliving systems, the rate of heat flow from a body to its environment is directly proportional to its temperature gradient. Warm blooded animals maintain constant body temperature at different environmental temperatures by various thermoregulatory devices.

"Thermoneutrality" is an environmental temperature at which the animal does not have to employ any of its thermoregulatory devices to keep its body temperature constant. This is because the environmental temperature is perfectly adjusted to keep the body temperature at its normal level without thermoregulatory devices. At thermoneutrality the animal feels neither hot nor cold. Thermoneutrality is a temperature zone close to the engineer's comfort zone. Its upper limit is about 85 F. Heat production is minimum at thermoneutrality.

At temperatures below thermoneutrality the animal keeps warm first by physical methods, not involving increase in heat production; then, as the temperature declines, by chemical methods involving increased heat production. Most farm animals can withstand low temperatures without discomfort and without much energy expense for keeping warm, because (1) under outdoor conditions of life they develop excellent insulation against cold in the form of hair, wool, or subcutaneous fat, and (2) their winter feeds have very high heat increments of feeding.

At temperatures below thermoneutrality, heat dissipation is mostly (up to about 70 per cent) by radiation of infrared waves. The remainder of the body heat is dissipated by convection and conduction (10 to 30 per cent, depending on air movement and conductance of environment), and by water vaporization (20 to 28 per cent), from lungs and skin, not involving vaporization of sweat. Humidity of the environment is not an important factor in heat dissipation at the lower temperature.

At temperatures above thermoneutrality (above about 85 F) the burden of heat dissipation is rapidly shifted from radiation and convection to vaporization. When the environmental temperature reaches or exceeds the level of skin temperature (about 95 F), all the heat is dissipated by vaporization; and when the environmental temperature rises still higher, vaporization dissipates not only the heat produced by the body, but also the heat absorbed by the body from the hot environment.

The reaction of animals to a hot environment depends mainly upon their ability to sweat, and on the conditions which affect vaporization—humidity and air movement. However, hot air movement is helpful only to sweating animals. Animals with dry skins are injured rather than

[*Concluded on p.* 592]

SUMMARY

**These excerpts from a much more extensive paper explain the effect of environmental temperature, humidity and air motion on various animals. Reaction of animals to a hot environment depends mainly upon their ability to sweat and hot air movement is helpful only to sweating animals; animals with dry skins are injured rather than benefited by fanning although a good fan may keep a sweating animal comfortable. . . . . Adaptive powers to cold are very much greater than to heat and this is particularly true of the nonsweating, furry, relatively large animals such as sheep, cattle and dogs. Practically, this means that it is not so difficult or important to protect an animal from cold as from heat**

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*Excerpts from a paper presented before the farm structures division at a meeting of the American Society of Agricultural Engineers. Dr. Brody is professor of dairy husbandry at the University of Missouri.

# Unusual Air Conditioning Problems

## . . . and how they are solved in the motion picture industry are explained by Arthur J. Hess of English & Lauer

AIR CONDITIONING for motion picture studios can be divided into four general classifications in accordance with the requirements of four of the divisions of production. These are:

1) The administrative division—offices of executives, writers, directors, cartoonists and others. Air conditioning follows the general practices of comfort conditioning with a few essential differences.

2) Sound stages. The conditions required on these stages are normally standard comfort conditions, but methods of conditioning, air distribution, control and problems due to sound and internal heat change, are peculiar to sound stages alone.

3) Film laboratories, which involve essentially industrial air conditioning problems, the solution requiring an intimate knowledge of the process and the conditions it requires. Cleaning the air is the most important problem, humidity control second, and temperature control is usually incidental.

4) The film handling division, which has to do with film storage and cutting, in which the control of the humidity is the essential.

Air conditioning installations in the administrative departments are, as mentioned, more or less standard comfort jobs. There are, however, a few differences of interest to the engineer. For one thing, a large percent-

**The sound stages present air conditioning problems of their own, on account of the heavy lighting loads, the wide variations in occupancy, construction of the sets, and so on. Note that apparently all air flow is screened off due to construction of the set, except for air which may come in from the camera side**

age of the occupants of the administrative units of a picture studio are artists—writers, directors and painters. As artists, they are typically temperamental and any design which does not take this fact into account can be only partially successful. In addition to temperament of the artists, executives are forced to solve seemingly impossible problems (such as the creation of desirable scenic effects of all ages, times and places on very short notice) and they think all problems are as easily solved. Interpreted in terms of design of air conditioning systems, the temperament of the artists and the training of the executives for "accomplishing the impossible" means that each room is expected to be so controlled that any temperature, within reasonable limits, may be produced in each individual room at the will of the occupant. This, of course, requires that each office must have a separate temperature control system that can be adjusted by the occupant.

It has also been found that air for such spaces should be all outside air, for any attempt at recirculation usually results in complaints. The systems in two of the major studio office buildings are arranged for individual control by means of thermostatically controlled mixing dampers, using all outside air and constant air volume, and there have been practically no complaints from the occupants.

### Sound Stages Present Unique Problems

The problems involved in sound stage air conditioning are also comfort problems, but the solutions are peculiar to sound stages only.

### SUMMARY

**Air conditioning for motion picture studios involves a number of unusual problems, the solutions of which are of interest in connection with applying air conditioning in other industries and in comfort work. Movie studio air conditioning may be classified as: (1) administrative division; (2) sound stages; (3) film laboratories; and (4) the film handling division . . . . Installations in the administrative departments are more or less standard comfort jobs but—as explained by Mr. Hess—particular attention must be paid to the temperament of studio executives, writers and artists . . . . . The sound stages—large, barn-like structures—are in a class by themselves because of their size, the necessary sound insulation, the huge lighting loads, the sets that are constructed on them, the importance of smoke removal, and so on. Filtration is important; relative humidity must be kept above 55 per cent to prevent accumulation of static charges on the moving film in the cameras, and for consistent results in sound recording. Properly designed and operated air distribution is vital; heat and smoke must be picked up and carried away from the lower 12 ft level, noise must be kept to a minimum, and the air mustn't move the canvas scenery representing a heavy brick wall, for instance . . . . . Control must be automatic. Quite often in winter, stages which are heated during rehearsal will require cooling during the actual shooting because of the lighting load . . . . . Air conditioning for the film laboratories—where cleaning and humidity control are the important factors—and for film handling—where control of humidity is the essential—will be explained more fully in a second article**

In order to understand these problems, it will be necessary to get a mind's eye picture of one of these stages. Usually it is constructed like a large barn, approximately 135 ft wide by 225 ft long by 50 ft high, and is free of any columns or other internal structure. The side walls and roof are lined with a 4 in. (or more) thickness of rock wool for sound control. The floor is usually raised a few feet from the ground and is of heavy timbers so that heavy sets can be constructed upon it; these floors are not usually insulated. The 4 in. sound insulation is not for thermal insulation, for there are many times when the internal heat load is so large that the thermal value of the insulation is negative, because the internal heat is held in the stage. Now, imagine a scene (or "set," as it is called) for a picture constructed on the stage. This set might be a complete hotel room in one corner of the stage, a complete skating rink set up like a village pond with entering brooklets, foot bridges and trees, which occupies the whole stage, or almost anything. It is part of the problem, as we shall see, that backgrounds of sets are usually constructed of 2 in. x 4 in. wood framing with walls, hills, mountains, etc., painted on canvas and nailed to the frame.

After the set is constructed, the props are brought in and the scene is dressed up for "shooting." Those who are camera fiends know the importance of light in a good amateur picture. The same is true in moving pictures—only more so. Huge klieg lights illuminate the set and many spotlights give proper highlights and shadows. Care must be exercised to see that shadows correspond to the imaginary times and directions of the pictures and failure to use proper care in this will result in many letters of complaint from sharp-eyed theater patrons. The cooling load due to the lights quite often amounts to more than 2000 kw, which any engineer will acknowledge is a tremendous cooling load with which to reckon.

Most of these huge lights are carbon arc lights. During rehearsals and actual filming the human load may be anything from six people to over 500, and their activity anything from quietness to maximum physical exertion. To complicate this problem, the actual shooting of each scene is preceded by many rehearsals just before the shooting takes place and the actual scene is then usually shot and recorded from four to a dozen times. Rehearsals are held just before shooting to eliminate actors having to memorize too much at any one time, so that most of their energy can be devoted to action rather than memory work. After rehearsals, each scene is shot many times until the director is satisfied with the results, and so that a choice can be made of the best shot.

Equipment design and capacities for sound stages follow regular practice, with the possible exception that the system must be designed so that all outside air can be circulated:

1) The motion picture people desire all outside air and note immediately any attempt at recirculation.

2) The lighting load is so high that there is usually no economy in recirculation of the hot return air.

3) The arc lights emit smoke which forms a haze on the stage that affects the quality of the camera work if recirculation is used.

Recirculation is usually used for heating or cooling the stage before occupancy, especially when the stage must be prepared on short notice—a not unusual condition.

In the better studios filtration of air for stages is regarded as important, because filtered air keeps snow and other white scenes clean and usable for a longer time, and because of the acknowledged physiological values of filtered air. Cellulose filters with renewable media have been used with success.

Fans and distribution systems for stages must have variable capacities so that volumes of air can be easily increased to remove smoke created on the set for scenes using smoke. Fans are usually picked to give an air change every seven minutes in the lower 12 ft level of the stage (what happens above the 12 ft level is immaterial to the picture.)

Stage air conditioning apparatus must be capable of controlling the humidity for two reasons:

1) Relative humidity must be held above 55 per cent to prevent accumulation of static electrical charges on the moving film in the cameras.

2) Humidity must also be held at some constant figure to give consistent results in sound recording. The quality of sound and sound propagation changes with the relative humidity of the air through which the sound passes. Some point between 55 and 60 per cent is the relative humidity usually used.

In Southern California we have found that there are many summer days in which we must cool and humidify—a design requirement usually not met with by eastern air conditioning engineers. At a studio with most successful sound stage systems, humidity is added by misting sprays using city water under pressure, with control by means of a humidistat on the stage.

## Air Distribution on Stages

The problems presented by the requirement of properly introducing the air are probably the hardest to solve. Experience has indicated that a series of outlets just above the floor around the stage is usually best, because by use of low outlets the conditioned air can be distributed into the action space under the klieg lights and allowed to rise through the lights—picking up both the heat and smoke from the lights and carrying these undesirables out of the shooting zone. Reference has already been made to the terrific cooling load occasioned by these lights. Also, where fire scenes are being taken, this type of air distribution makes it possible to carry off smoke with a minimum of interference with the shooting.

Economically speaking, the major value of an air conditioning system on a stage is to allow for continuous rehearsing and shooting. On an unconditioned stage it is necessary to stop about every 30 minutes, shut off the lights and open up the huge stage doors for 15 minutes or so to clear the stage of the hot, smoky air. This means one-third more time is consumed in actually taking the picture, which in turn means huge sums spent for extra wages paid without work, and delay in the time it takes actually to get a picture into the hands of exhibitors.

The velocity that can be used in air outlets on sound stages must be low for two reasons: (1) air noises must be kept to a minimum, and (2) lightly constructed scenery must not waver under a blast of air. As to noise—good design of an air conditioning system calls for a maximum increase in the stage noise level of only eight decibels due to the air conditioning; the stage noise level is taken at 2:00 a. m. on a vacant stage lined with 4 in. of mineral wool. Few other applications have as stringent an acoustical requirement as this.

Blasts of air directed against scenery (which is usually painted canvas on light wooden frames) will cause the scenery to waver—an impossible situation especially if the scenery in question is supposed to represent a heavy brick wall. This problem of distribution is a difficult one when the scenes are built within a few feet of the air outlets. It has been found that face velocities of not more than 150 fpm through grilles are about right.

It would appear to most engineers that such a distribution system would fail to get the conditioned air into the center of the stage, especially when (as is often the case) the sets are built up so that the space in the center of the set is isolated from the balance of the stage except through doors and windows in the set and over the open top. A study under actual operating conditions indicates that the chimney effect of the light load above the set pulls the cool air along the floor and into the set, though in some cases the space under the stage is made into a plenum and trap doors are scattered throughout the stage floor in order that by opening the proper doors air can be delivered to the desired places on the stage.

The stages of the 20th Century-Fox studios are good examples of successful practice as used in Hollywood. A typical stage of this studio is 135 ft wide by 220 ft long, and the air conditioning system has a peak air capacity of 90,000 cfm. Both supply and exhaust systems have variable speed motors.

The air distribution system is made up of heavy galvanized corrugated culvert pipe with most of the inside surfaces lined with 1 in. of acoustic material which serves as both sound and thermal insulation (though concrete trenches are now usually used.)

Air is introduced into the stage at intervals of about 30 ft around the wall using screened outlets designed for a maximum air velocity of 150 fpm. The outlets have sloping tops and are about 3 ft above the floor of the stage. The exhaust system consists of a large rectangular duct placed at the top of the stage and running the length of the longitudinal center line. The exhaust outlets are openings in the side of the exhaust duct and are equipped with sliding dampers for adjusting as required by the set in use. This damper adjustment is easily made from the inside of the duct, since the duct is approximately 8 ft wide by 6 ft 0 in. high. Exhaust air is drawn back to the fan room by the exhaust fan where it is exhausted or recirculated as desired. Recirculation is seldom feasible for reasons already stated.

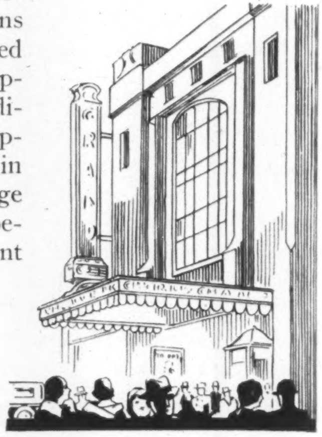
Outside air and such recirculation as is used is drawn into the supply fan through filters of the pocket type using cellulose media. The supply fan forces the air through two rows of copper finned steam heating coils, followed by a chamber type humidifier using city water in the misting sprays, followed by six rows of chilled water cooling coils of the serpentine type. Finally the conditioned air is forced through the supply duct system into the stage.

### Control Requirements

The system must be fully automatic in operation, including changing from cooling to heating, since either may be required at any time regardless of outside conditions. As a matter of fact, quite often in the winter, stages which are heated during rehearsal will require cooling for actual shooting due to the light load. Humidity control must act independently of temperature because humidification is often required during the cooling process, in addition to the usual added humidity requirements of the heating process.

The control of cooling is by means of modulating type three-way valves controlling the flow of chilled water to the coils and acting under control of room thermostats, with limit stats in the coil discharge chamber to regulate the dew point in cases of dehumidification; heating is controlled by a modulating steam valve supplying steam to the heating coil and acting under control of another room thermostat. Humidity additions are controlled by a motorized water valve on the spray supply under control of a humidistat on the stage. The equipment room is underground in a room adjacent to the stage with all building joints between stage and equipment rooms isolated with felt and asphaltum.

[*A second article by Mr. Hess will cover air conditioning for film processing and film handling.*]



# Air Conditioning May Halt Decentralization in Cities

Modern office building construction with conditioned air free of dirt and smoke, and artificial light that rivals the natural product, may offer the specific necessary to offset the decentralization of downtown business districts with the accompanying expensive obsolescence of downtown properties.

This is the conclusion of E. M. McConney, vice-president and actuary of the Bankers Life Co., Des Moines, Iowa. Mr. McConney served as chairman of the building committee responsible for the location and erection of the company's $2,000,000 home office building completed this past summer near the heart of the Des Moines business district. Features of the structure were described in the July, 1940, HEATING, PIPING AND AIR CONDITIONING.

Mr. McConney said Bankers Life considered both a suburban and a downtown site, but decided in favor of a downtown location "because air conditioning is looked on as an economical necessity and that solves the problem of downtown smoke and dirt."

Double glazed windows, never opened except for cleaning, keep out dirt. Two inches of cork insulation from basement to roof insulate the building against noise as well as heat and cold losses. As a result, Mr. McConney contends, the downtown location has all the advantages of a suburban site save one—parking convenience.

# Comparative Merits of Zoning Methods

Walter A. Grant* presented an analysis of zoning at the spring meeting of the American Society of Refrigerating Engineers and pointed out the importance of adequate zoning cannot be over-estimated. One of two air conditioning installations similar in every other respect may be zoned inadequately and may well be a complete failure and source of other dissatisfaction to the buyer. Poor zoning, he said, cannot usually be easily corrected in the manner that one would correct a defective piece of equipment, for it frequently means ripping out portions of the duct and piping systems by the roots.

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*District Chief Engineer, Carrier Corp.

| | TYPE | SUPPLY AND VENTILATION AIR VOLUME | AIR COOLING APPARATUS SIZE DETERMINED BY | REFRIGERATION APPARATUS SIZE DETERMINED BY | IS SIMULTANEOUS HEATING-COOLING POSSIBLE? | COMPARATIVE FIRST COST | COMPARATIVE OPERATING COST | COMPARATIVE QUALITY OF RESULTS |
|---|---|---|---|---|---|---|---|---|
| A | Separate apparatus for each zone | Constant | Each zone maximum load | Bldg. maximum load | Yes | High | Lowest | Good |
| B | Zone recirculating fans | Constant | Building maximum load | | Only by adding reheat (D) | Medium | Fairly low | No good without reheat<br>Good with reheat |
| C | Dual duct system—cooling through one duct heating through other | Constant | Building maximum load | | Yes | High | Lowest | Good |
| D | Reheat or re-cooling | Constant | Sum of zone maximum loads | | Yes | Medium | High | Good |
| E | Volume dampers | Variable: maximum to zero | Building maximum load | | Only by adding reheat (D) | Low | Low | No good without reheat<br>Fair with reheat |

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# Radiant Heating and Cooling

## Warm Air Type of Panel Heating Analyzed, and Other Types of Installations Described, by F. E. Giesecke*

SUMMARY

**Dr. Giesecke has explained in previous months the fundamentals of radiant heating and cooling, has presented necessary data for figuring such installations, and has described in detail the calculations for designing floor coil and ceiling coil heating panels. This month, he discusses an interesting suggestion for warming a ceiling with air so that the ceiling will heat a room by radiation. Assuming a room of certain dimensions and heat loss, he shows how the quantity of air and its temperature could be figured, giving enough information so that the reader can follow through the explanation and apply the method in practice. . . . To conclude this month's discussion, the author briefly describes a number of radiant heating and cooling installations. Particular attention is given to a department store in Zurich, Switzerland, one part of which has ceiling pipe coils for heating in winter and cooling in summer. The coils also supply part of the steel reinforcement for the concrete slabs. Studies were made of the possibility of condensation, and of the results obtained in cooling service, and the results are graphed. Another installation of particular interest is in an operating room in a Grand Rapids hospital, which has wall panels for cooling the surgeons by radiation**

AT a recent meeting, E. A. Jones of the Wisconsin chapter of the American Society of Heating and Ventilating Engineers suggested that the cost of installing a ceiling panel or radiant heating system might be materially reduced if the panel were heated by a blanket of warm air flowing along the ceiling instead of by warm water flowing through pipe coils embedded in the concrete slab. This plan seems feasible if it may be judged by the following calculations.

If the room shown in Fig. 11 on p. 358 of the June HPAC has a heat loss of 6000 Btu per hr and its heating panel is to be designed for an air temperature of 68 F and a mean radiant temperature (MRT) of 74, and the entire ceiling (12 ft by 15 ft) is to be the heating panel, the heat dissipation of the ceiling must be at the rate of 6000/180 or $33\frac{1}{3}$ Btu per sq ft. If one-third of this heat is delivered by convection, about 22 Btu per sq ft per hr must be delivered by radiation; the ceiling temperature must therefore be 96 F, according to Fig. 1, p. 485, August HPAC.

If the blanket of warm air is to move across the ceiling at a rate of 50 fpm or 0.57 mph, the value of the film coefficient would be about 2, according to the ASHVE Guide. If, to be safe, its value is placed at 1.5, the mean temperature of the blanket of warm air in contact with the ceiling must be 96 F + ($33\frac{1}{3} \div 1.5$) or about 119 F. If the blanket of warm air is 9 in. or 0.75 ft thick, the volume moving across the ceiling in an hour is $180 \times 0.75 \times 50 \times 60$ or 40,500 cu ft per hr. The weight of 1 cu ft of air at 70 F (530 F absolute temperature) is 0.075 lb; therefore the weight of this volume of air at 119 F (579 F absolute temperature) is $40{,}500 \times 0.075 \times 530/579$ or 2780 lb. If the specific heat is placed at 0.25, the air will deliver 2780/4 or 695 Btu per hr to the ceiling heating panel for every degree its temperature is lowered. Therefore, to deliver 6000 Btu per hr, its temperature must be lowered 6000/695 or 8.7 F — say 10 deg.

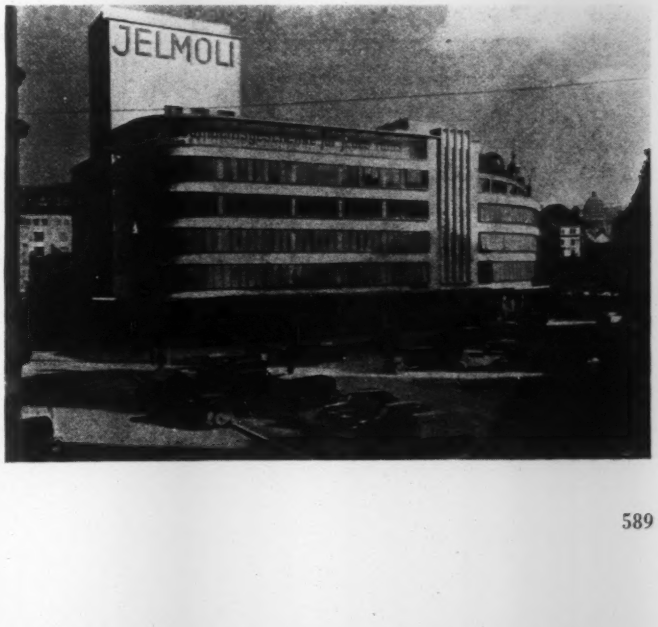
Hence, the air should enter the room through several wide registers just beneath the ceiling at one end of the room, at a temperature of 124 F and leave through similar registers at the other end of the room at a temperature of 114 F. The current of warm air, flowing along the ceiling, would then deliver 6000 Btu per hr to the ceiling panel by conduction, and the ceiling panel would deliver 6000 Btu per hr to the room, part by radiation and part by convection. In addition, the air ducts in the end walls leading to and from the registers would heat the end walls so that these walls would also become heating panels. By virtue of the convection air currents which would be produced by the heating ceiling panel, the air in the warm air blanket would be mingled to a certain extent with the room air, and the incoming warm air could be treated as supply air which could be filtered and humidified so that this type of panel warming would partake of the nature of air conditioning.

From a theoretical point of view, this system suggested by Mr. Jones seems quite attractive.

### Panel Warming Installations

Since panel warming was first developed in England, the largest number of such installations exist there.

**Fig. 1—The newer part of this Swiss store has ceiling panel coils for heating in winter and cooling in summer**



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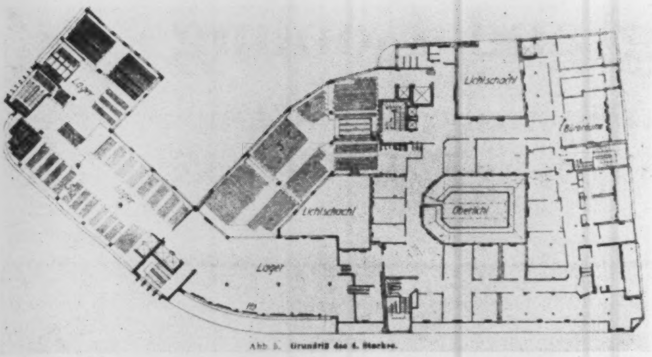


**Fig. 2—This plan gives an idea of the coil installation for the department store shown in Fig. 1. The pipe coils are used for heating, for cooling, and reinforcing the concrete slabs**

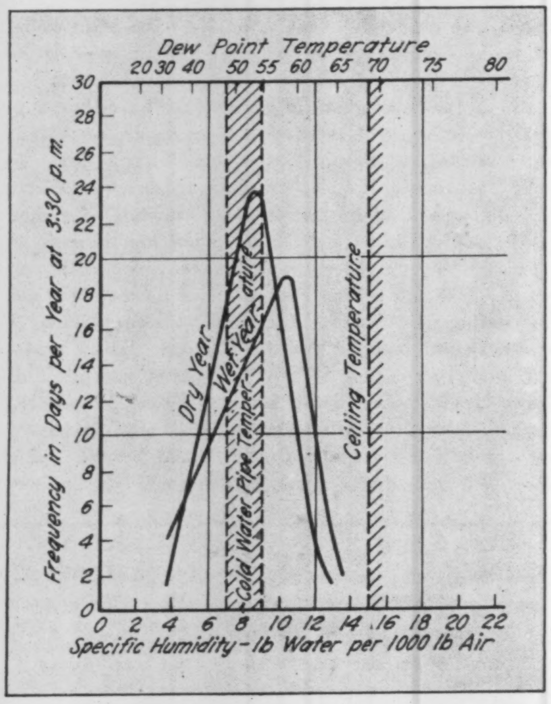
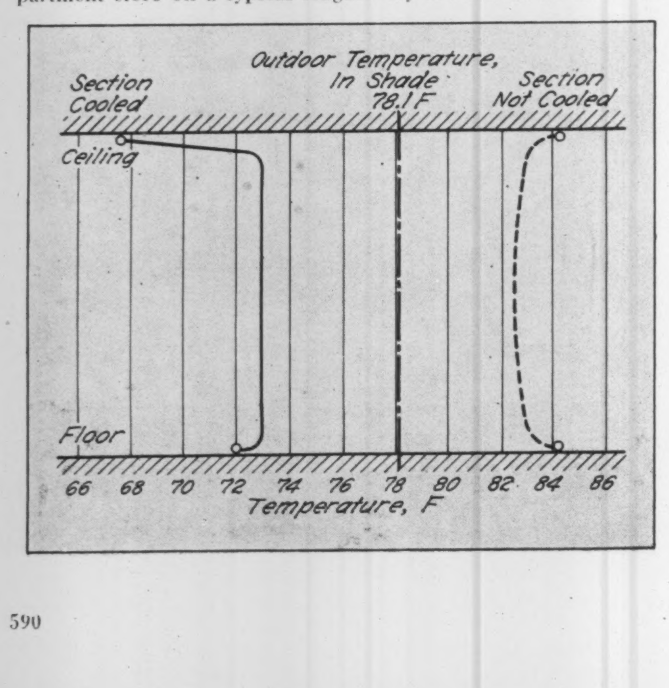


**Fig. 3—A study made for the building of Figs. 1 and 2 indicated that if the ceiling temperature is not allowed to fall below 70 F for cooling service in summer there is no danger of condensation**

**Fig. 4—Results of cooling by ceiling panels in the Swiss department store on a typical August day are shown on this chart**



There are also many installations in other European countries but comparatively few in the United States and Canada. A very interesting installation is shown in Figs. 1 and 2—a department store in Zurich, Switzerland. The older portion of the building was erected about 12 years ago and equipped with standard radiators; the newer portion was built about three years ago and equipped with ceiling panels. The interesting feature in this building is that the coils are used to heat the building in winter, to cool it in the summer, and to supply a portion of the steel reinforcement needed for the concrete slabs. To determine whether the coils could be used for cooling without danger of condensation on the ceiling, a study was made of the specific humidity as shown in Fig. 3, and it was found that if the ceiling temperature is not allowed to fall below 70 F there is no danger of condensation.

The results of the summer cooling for a typical August day are shown in Fig. 4. The temperature in the new portion of the building is about 10 deg lower than in the old portion, which is not cooled. Temperature of the cooling water was about 50 F.

The first important building equipped with panel heating in the United States was the British embassy building in Washington, in which the heating was installed under the direction of Wolff & Munier. Another building equipped in a similar manner is the Metropolitan State Hospital, Waltham, Mass. A panel heating system installed in the Everett, Wash., high school under the direction of E. L. Weber was described in the May, 1940, HPAC.

### Radiant Cooling in Hospital

An interesting example of a radiant cooling system may be seen in one of the operating rooms of the Blodgett hospital in Grand Rapids, Mich., described by Drs. C. A. Mills and John Gorrell in the December, 1938, HPAC. In this installation metal sheets, about 36 x 120 in., are suspended from the walls at an elevation equal to that of the operating table. These sheets are cooled by pipe coils attached to their rear surfaces through which 40 F water is circulated. The condensate which forms on the metal sheets is collected in troughs underneath the sheets and discharged. The surgeons operate between the two cooled metal sheets and, in that way, dissipate a considerable portion of their body heat by direct radiation to the cold panels.

There are a number of other installations in existence, both for heating and for cooling, but space is not available to describe additional details.

[*This is the fifth of Dr. Giesecke's articles on radiant heating and cooling. The first was published in the June, 1940, HPAC.*]

### Sun Heats Water for USHA Project

Water heated by the sun is a feature of "Edison Courts," Miami, Fla., a 345 dwelling unit United States Housing Authority public housing project.

The system, which also is to be installed in another large USHA project to be built at Fort Lauderdale next year, is a simple one. Shallow, glass covered trays are built into the roof surface so as to obtain a maximum of sunlight exposure. Inside the trays are tubes of copper resting on a copper base. The tubes run from the heater trays to a well insulated storage tank, also on the roof. Water, sun heated in coils, is stored in the tank.

# Piping Changes Increase Efficiency

## How Large Building Heating Has Been Improved by Modernizing the Piping Told by William S. Downs*

THE heating of radiators in remote sections of large office buildings is frequently difficult due to obstructed steam flow. This may be attributed to one or more of the following factors: (1) Unreamed pipe ends. (2) Partial stoppage of flow through an accumulation of scale. (3) Horizontal piping may not have sufficient pitch to allow the condensate to drain off. (4) Piping is sometimes indirectly routed.

To keep frictional flow losses in hand, piping should be routed as directly as is feasibly possible. Miscalculations in layout during construction are not uncommon and the experienced operator does not hesitate to correct them when necessary.

### Condensate Piping Revised

In one large office building, the condensate from an extensive system returned to a water leg in a trench below the engine room floor. Three vacuum pumps were connected to the other end of the leg by means of two lift fittings, the center lines of which were 5 ft apart —conventional wet return, but the siphoning over of the condensate precluded efficient pump operation due to the spacing of the lift fittings. Heavy slugs of water intermittently pounded against the gooseneck bend of the upper fitting, causing the whole header to vibrate. The variable load thus imposed on the pumps caused them alternately to race and slow down and the vacuum gage readings fluctuated from 3 to 6 in.

The 8 in. header had been installed to run 18 in. higher than the pump suction outlets. It was evidently thought that the pump strainers had to face outwardly while the header must be kept close to the pumps to economize on space. The extra height was then compensated for by dropping the 4 in. branches to pumps as shown in Fig. 1. Five elbows were used in each branch and the total suction lift was responsible for a constant 3 in. vacuum differential between the pumps and building return piping.

After studying this hook-up a means was devised to

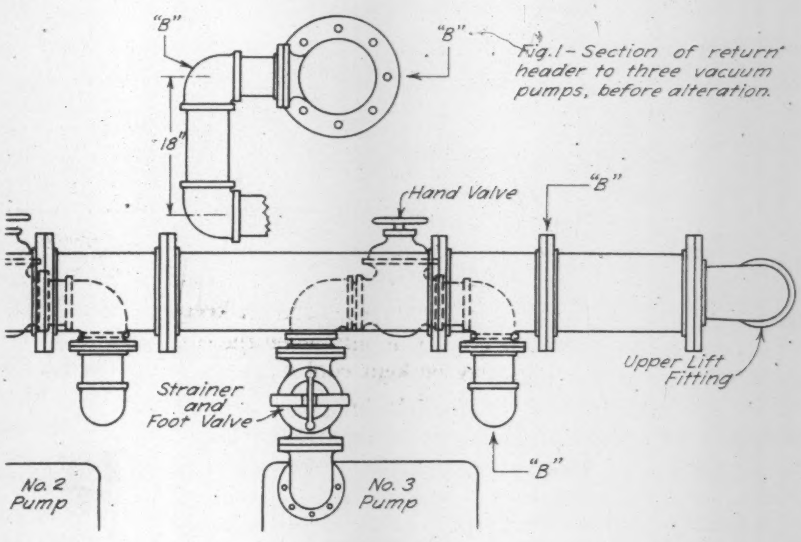


Fig. 1–Section of return header to three vacuum pumps, before alteration.

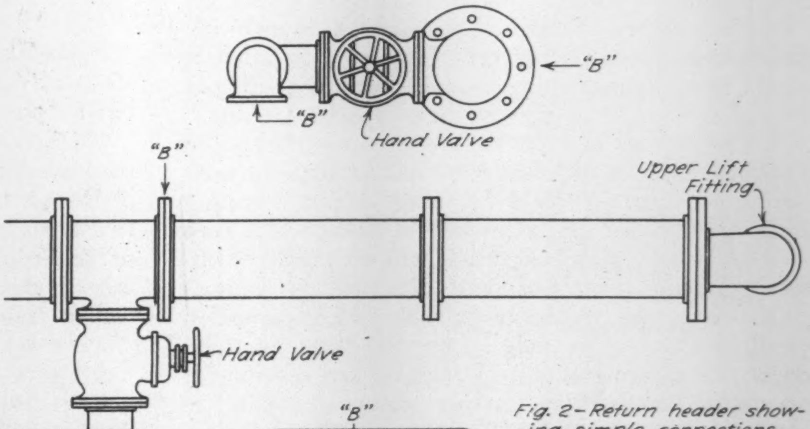


Fig. 2–Return header showing simple connections after alterations. Upper lift fitting dropped 18 in.

### SUMMARY

**Heating of radiators in remote sections of large buildings is frequently difficult due to obstructions to steam flow caused by unreamed pipe ends, partial stoppage of flow through an accumulation of scale, insufficient pitch of horizontal piping to allow condensate to drain off, and indirect routing of piping . . . As an example of how piping can be altered to improve results, Mr. Downs cites a case where a change was made in the piping for an office building which resulted in smoother pump action, more even distribution of steam and economy in steam consumption . . . Unreamed pipe ends in a piping system may be the cause of trouble. The sketches of Fig. 3 indicate how greatly the effective area of a piece of pipe can be reduced on account of this. These sketches were made from actual samples taken from the heating system of an office building and showed that the effective area of the ½ in. size was reduced 45 per cent, the ¾ in. size 40 per cent, and the 1 in. 28 per cent**

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*Assistant Engineer, Irving Trust Bldg.

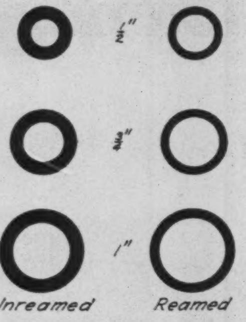

Fig. 3—This sketch—made from actual pipe ends removed from a heating system—indicates how greatly their effective area may be reduced.

lower the 8 in. header in the manner shown by Fig. 2. There were removed in the change nine 4 in. elbows, 15 ft of 4 in. pipe and 6 ft of 8 in. pipe. This last included an 8 in. tee which was disposed of by connecting No. 1 pump directly to the flanged end of the header through a reduction fitting. By turning the suction strainers at right angles to the pumps it was possible to make the branch connections with two elbows instead of five, reducing the center lift distance to 3½ ft.

Vibration of the header was thus cut to a barely perceptible minimum and the vacuum differential across the leg decreased to 1½ in. This gain was reflected in smoother pump action, quicker and more even distribution of steam to the system and economy in pounds of steam used.

### Reaming Pipe Ends

It is a deplorable fact, too, that in the rush of construction, or due to carelessness, scant attention is sometimes given to the reaming of pipe ends that have been cut on the job. The pitch of horizontal run-outs is easily corrected but to remove, ream out and replace hundreds of pipe sections is an undertaking that involves terrific expense. Most risers and run-outs are concealed within the walls and may only be reached by breaking through the plaster. Even then it is no small job to unscrew a section of pipe where the working space is limited.

A heavy inturned burr caused by a single wheel cutter reduces the effective area and in horizontal piping some condensate is trapped. In a single case, the amount of water that will not drain away is practically negligible. But where several thousand run-outs to radiators are involved, the total effect may be quite wasteful.

Reference to Fig. 3 illustrates how the effective area of pipe may be reduced. These are drawings of actual pipe ends removed from the heating system of an office building. All are standard brass pipe of the type commonly used for steam heating run-outs and radiator connections.

The reduction in effective area amounted to 45 per cent in the ½ in., 40 per cent in the ¾ in. and 28 per cent in the 1 in. sizes. The ½ in. pipe suffered the greatest loss in effective area but as a rule it is used on returns where the effective area is not so highly important. However, the unreamed end of any pipe will catch and hold sediment which in time builds up to reduce further the effective area.

[*Readers are invited to contribute comment on their experiences in improving large building heating systems for publication in our "Open for Discussion" pages.*]

## How Animals React—

[*Concluded from p.* 584]

benefited by fanning, because the high environmental atmosphere is driven against the cooler skin, thus heating instead of cooling the animal. Fanning does not help vaporization from the lungs because the lungs act as their own fans. Nonsweating animals may be kept cool by keeping their skins moist and fanning them only when the skin is moist. Sweating animals may be kept cool by fanning, and, if possible, dehumidification. A prime factor in keeping cool in all cases is to reduce the heat increments of muscular exercise and of feeding in the heat of the day. The importance of sweating and of keeping the skin moist for keeping cool is indicated by the fact that in sweating animals from 40 to 95 per cent of the vaporization is from the skin. Nonsweating animals resort to panting in hot weather in order to increase their vaporization rate.

The engineering problem of keeping animals cool in hot weather is quite different for sweating than for nonsweating animals. A good fan may keep a sweating animal comfortable. But a fan will do little good to keep a sheep, cow or dog cool because it will not greatly facilitate vaporization from the skin. Nonsweating animals such as cattle could probably be cooled by vaporization as well as sweating animals by keeping them moist by sponging or covering with a wet blanket and fanning. It is suggested that facilities for this manner of cooling be extended to high-producing dairy cows that are particularly in need of cooling because of the high heating value of their feed.

Unlike protection against heat, protection against cold is not influenced importantly by humidity because heat dissipation in cold weather is mostly by radiation and convection and but slightly by vaporization; although below 45 F, humid air feels colder to a person than does dry air because the conductivity of the clothing is increased. The body has more defenses against injurious effects of cold than of hot environments.

It is instructive to observe that the adaptive powers to cold are very much greater than to heat. This is of course particularly true of the nonsweating, furry, relatively large animals such as sheep, cattle and dogs. Practically, this means that it is not so difficult or important to protect an animal from cold as from heat.

### Air Raid Shelters Studied

Apace with today's troublous trends, United States Housing Authority engineers are studying air raid shelters for possible inclusion in low rent housing projects.

USHA engineers have discarded the suggestion of reinforced floors above cellars because such construction in Europe has been ineffective. They now are studying two types of "pill boxes." One type is oblong with a parabolic cross section tapering towards the top. The other is dome shaped. The latter should give more protection from gunfire and bomb fragments, USHA engineers say, but no "pill box" so far devised provides much protection from a direct hit by a bomb.

The idea of reinforcing the floor above the cellar was dropped after consultation with Michael Rosenauer, noted British architect. In Spain, he says, debris of buildings demolished by bombs frequently blocked entrances to bomb-proof cellars and occupants often were suffocated before they could be removed.

Photo by the Detroit News

These technicians at the Parke, Davis biological manufacturing laboratories are testing sera and anti-toxins. Air conditioning is an essential service in making these products

# Air Conditioning Serves Mankind

## Modern Pharmaceutical Manufacture Depends Upon Clean Air, Controlled Temperatures and Humidities, Says E. P. Heckel*

**SUMMARY**

**The "medicine man" of today is the scientifically skilled and schooled technician possessed of an accumulated knowledge attained after many years of study and of a thorough understanding of the organic system, the complex chemistry of the body, and its functional reactions and requirements. Scientific developments and constant research carried on by the medical profession and the pharmaceutical manufacturer have enhanced the knowledge of medicine beyond measure. . . . Air conditioning plays an important part in making pharmaceutical products. Cleanliness is essential, as are controlled temperatures and humidities. At the Parke, Davis laboratories in Detroit, air is multiple filtered, temperature and humidity is kept at 75 F and 40 per cent, air motion at a minimum. The author briefly describes how this is done**

SINCE time immemorial the primary natural instinct of man has been self-preservation. Thus food and shelter were the earliest recognized prerequisites to sustain life.

The art of kindling a fire for the cooking of wild meats and to provide bodily warmth to resist the cold was undoubtedly one of the truly great accomplishments of early man. Then followed slow, gradual improvement through countless ages in methods for capturing animals for food and skins for body covering, the crude tanning of pelts for body protection, the making of stone implements, etc. Families joined groups and groups became tribes for mutual protection; later, these tribes selected leaders to guide them and chose medicine men to administer to their ills.

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*E. P. Heckel & Associates. Member of HPAC's Board of Consulting and Contributing Editors.

Gradually there developed a crude understanding of the medicinal values of certain herbs, roots, spices, tree barks and vegetables which were brewed according to prescribed fashion and when administered proved beneficial to the sick. The medicine man thus became one of the most important persons of his tribe. Developed from this crude and humble beginning, the "medicine man" is still among us to administer against disease and bodily ills. However, the medicine man of today is the scientifically skilled and schooled technician, possessed of an accumulated knowledge attained after many years of study and of a thorough understanding of the organic system, the complex chemistry of the body, and its functional reactions and requirements.

The scientific developments and constant research carried on by the medical profession and the pharmaceutical manufacturer have enhanced the knowledge of medicine beyond measure. The manufacturing and scientific developments for the extraction of products of medicinal values from herbs, roots, bark, vegetables and minerals, and the conversion of these to products of definite purity and potency, have progressed far beyond any methods heretofore known or recognized as possible.

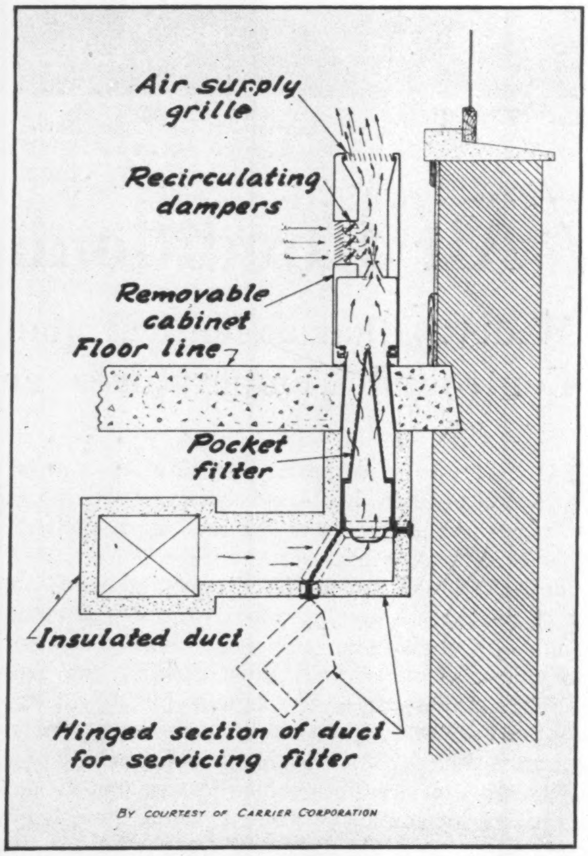
Cleanliness is one of the prerequisites that is constantly stressed in pharmaceutical manufacturing because its effect on the purity and quality of the product is well understood. Dust may be counted as Enemy No. 1 because of its ability to convey, produce and spread contamination. It is therefore obvious that the science of air conditioning plays a very important part in pharmaceutical manufacturing. Dust is kept out and is kept under control within reasonable safe limits; air temperatures and relative humidities are constantly maintained at a fixed and definite value most conducive to the product and to employee comfort.

The air conditioning systems recently installed for the biological departments of Parke, Davis & Co.'s new laboratory building in Detroit, Mich., may be considered as typical in many respects of those heretofore made. By these men of science, whose compelling desire is for better methods and more effective agents for combating disease, air conditioning is recognized as an important factor. Hence, the installations made and the conditions provided are in conformity with prescribed requirements and may briefly be enumerated as follows:—To provide in each of the 30 or more individual laboratories, a uniform temperature of 75 F with relative humidity of 40 per cent. This condition, with a minimum of air motion within each room and multiple filtering of air to minimize contamination possibilities from air-borne dust, is accomplished by the use of air cooling and dehumidifying spray chambers which have dry type unit filters at the front and discharge ends. Since no matter how thoroughly the air is cleaned up to this point there still would exist the possibility that some metallic salts or dust might be sluffed off from the inner surfaces of the air ducts and be carried by the air stream to the rooms, special pocket air filters were designed and installed in each air supply duct close to each room. These are easily accessible and readily removable for renewal of the filtering media.

All apparatus and equipment such as the refrigeration machines (which have the ability and most generally do set up vibrations easily transmitted to the building structure) are mounted on heavy concrete slabs of calculated design and weight which are supported and held in suspension by special steel coil springs. These springs are designed to carry the entire weight with a fixed deflection to absorb all of the vibrations which otherwise would be transmitted to the building structure. These vibrations could prove very troublesome to the toxin processing.

The prescribed low air change with minimum air motion, so important for each of the laboratories, was achieved by the accumulated advantage of several factors; first, by cooling and air conditioning the areas surrounding the laboratories—the corridors and the space above the ceilings—the heat transmission through the room walls and ceilings was minimized, thus preventing wide fluctuations of heat transmission which otherwise would occur. Second, by using induction type air discharge units, a minimum air volume is supplied to each room at the required dew point temperature to meet internal load demands. The air thus supplied to each room is discharged upward from the unit. The air temperature is immediately increased by mixing with the secondary air drawn into the unit from the room by the high velocity air jet. The ratio of secondary air volume to primary air volume is approximately two to one. Each air discharge unit is mounted on the floor and may be easily taken apart for cleaning.

Investigation and tests for stray contamination, spore bacteria and mold which have been made since the installation was put into operation, have entirely justified the engineering details and the costs that were involved for air conditioning.



BY COURTESY OF CARRIER CORPORATION

**By using induction type air discharge units, a minimum air volume is supplied to each room at the required dew point to meet internal load demands. Ratio of secondary air volume to primary air volume is about 2:1**

# How Big Is a Boiler?

## Kalman Steiner* and Fred Ravnsbeck* Discuss the Methods of Rating Heating Boilers, Suggest Proper Care in Using Them

### SUMMARY

**Under possible interpretations of various rules for rating heating boilers, there can be as much as 35 per cent difference in a boiler's rating, the authors point out, and go on from there to explain how this has come about and the importance of double checking what is meant by boiler rating in specifications. Considerable effort has been expended by manufacturers and associations to set forth in concise fashion the rating or capacity of any boiler, and much good work has been done toward reducing boiler ratings to a universal basis. Disparity still exists, however. One reason is that in one case the rating is based on boiler output, while in another it is based on net load. . . . This review of the different bases for rating boilers indicates the need for double checking on what is implied by a specification for a new installation. The case of converting existing boilers from hand to mechanical firing requires even more careful consideration, as shown by the example of an industrial plant where boilers were installed at different times over a period of several years. As shown by the curves for a certain boiler, very little decrease occurs in efficiency by heavy overloading while the draft loss increases a great deal as load goes up. This should be remembered when designing a chimney for a boiler installation that is expected to carry overloads. It might be said that capacity of a boiler to absorb heat from the fire is limited only by the amount of heat that can be released in the firebox of the boiler and by the amount of gases that can be caused to move through the tubes**

"CONTRACTOR shall furnish a stoker or oil burner, capable of developing this boiler to 175 per cent of its rated capacity". . . . . Many specifications contain sentences similar to this one. How many times is the contractor, figuring up his bid, compelled to stop and meditate, "What is the rated capacity of any boiler? The manufacturer's? His catalog shows two ratings—one for hand firing and one for mechanical firing. If not the manufacturer's, then perhaps that issued by the Heating, Piping and Air Conditioning Contractors National Association? Or maybe that of the Steel Heating Boiler Institute (if it be a steel boiler), or of the Institute of Boiler and Radiator Manufacturers (for a cast iron boiler)? Or will the Guide of the American Society of Heating and Ventilating Engineers help clear up the question?"

Considerable disparity seems to exist in the quantitative data commonly associated with boiler ratings and boiler outputs, and in the related subjects of draft (or chimney requirements) and combustion volume. We do not mean to imply that most manufacturers and the various associations have not gone to considerable effort to set forth in concise fashion the rating or capacity of any particular boiler. Much good work has been done toward reducing boiler ratings to a universal basis. But that disparity still exists cannot be denied. Under possible interpretations of various rules there can be as much as 35 per cent difference in a boiler's rating, depending upon viewpoint.

It will be convenient to consider the matter of boiler ratings under three classifications of boilers: low pressure fire tube, high pressure fire tube, and cast iron. The basis for rating water tube boilers is essentially different from these three, and no attempt will be made to include water tube boilers in this discussion.

### What Is Boiler Heating Surface?

The fundamental unit, or starting point for the rating of steel boilers, is the square foot of boiler heating surface. According to the SHBI, heating surface refers to those surfaces in the boilers which are exposed to the products of combustion on one side and water on the other. The outer, or water, surface of tubes is used in SHBI ratings. This seems a fairly simple definition. Yet there is at least one large manufacturer of heating boilers who shows two sets of data on heating surfaces for some boiler types—one based on SHBI and the other based on American Society of Mechanical Engineers definitions. The ASME does not promulgate rules or data concerning the rating of boilers, but concerns itself only with the construction and safe operation of boilers, including testing. But the ASME does define heating surface of boiler tubes as being the fire side, and so there is immediate conflict between these two authoritative bodies.

The amount of heat transmitted through a square foot of heating surface will of course vary widely, depending upon the location of a particular square foot of surface with respect to the fire, the nature of the fire and fuel, the velocity of combustion gases, temperature differences, boiler water circulation, etc. It is not our purpose here to inquire into any phase of the complex subject of heat transfer in boilers. We must conventionalize the square foot of heating surface, as the entire industry does, and use it as if it were a definite and concise thing —which, of course, it is not.

The square foot of boiler heating surface seems to be the handiest unit for rating boilers. Whether it is logical or not will be brought out as this discussion proceeds. But we can definitely say that it is far from being an accurate one, for the good reason that the amount of heat transmitted through it varies greatly. But assuming that the heat transfer rate were a definite thing, how clear does it make the rating system of boilers? To what extent has the industry been able to express itself concisely in terms of this unit, even though the unit itself be of vague significance?

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*Ace Engineering Co.

### Basis of Rating Codes

For many years the boiler industry used the rule of thumb that 10 sq ft of heating surface in a boiler permitted the development of 1 boiler hp output. This is by no means the definition of a boiler horsepower, which in itself is a very definite thing. A boiler horsepower is defined by all authorities as the evaporation of 34.5 lb of water from and at 212 F, which is again equivalent to 33,475 Btu. Since the standard square foot of steam radiation is established as the emission of 240 Btu per hr, it follows that 1 boiler hp is equivalent to 139.4 sq ft radiation, usually rounded off as 140. It follows that if 10 sq ft of heating surface be considered to give a boiler 1 boiler hp capacity, then 1 sq ft of heating surface is equivalent to 14 sq ft of steam radiation.

In an attempt to reduce boiler ratings to some sort of comparable basis between manufacturers, the SHBI worked with the National Bureau of Standards in the preparation of a unified procedure, which rules were published as Simplified Practice Recommendation R-157-35. These rules constitute the basis for the boiler ratings now known as the SHBI code. This code states that the rating of a boiler burning hand fired solid fuel shall be 14 sq ft of steam radiation for each square foot of heating surface. It therefore follows that the Bureau of Standards and the SHBI have adopted the basis of the preceding paragraph, insofar as hand firing is concerned.

The HPACCNA promulgates very complete data concerning the net load capacities on all heating boilers listed with them. For hand fired steel boilers they have adopted a sliding scale, beginning with 10.77 sq ft radiation per square foot of heating surface for small boilers up to 11.67 sq ft for large boilers. These figures are really derived from the SHBI rule of 14 to 1, but the HPACCNA sets up reserves for piping losses, morning pick-up and attention factor, the reserve varying from about 23 to 16.7 per cent, according to boiler size.

Steel boiler manufacturers who are members of the SHBI rate their low pressure heating boilers intended for hand firing according to the SHBI code. Local associations of heating contractors use the HPACCNA recommendations. It might be mentioned that the hand fired recommendations of the HPACCNA are predicated on the use of a coal having a heat value of 11,000 Btu per lb for large boilers. Factors are given for correcting the net load recommendations on boilers when lower valued fuels are used. The SHBI is silent as to coal heat values in relation to boiler capacities.

It is of course a recognized fact that boilers can easily be taken up to larger outputs under mechanical firing than under hand firing. Accordingly, the SHBI code and R-157-35 state that with a stoker, oil burner or gas burner, the boiler heating surface shall be multiplied by 17 to arrive at the rating in square feet of steam radiation. The HPACCNA establishes mechanically fired ratios varying from 13.18 for boilers with 129 sq ft of heating surface up to 14.17 for boilers with 2500 sq ft of surface. The same percentage of reserve for piping and pick-up has been made as for hand fired steel boilers. As in the case of hand fired boilers, steel boiler manufacturer members show catalog ratings on the basis of the SHBI code, while local heating contractors' associations use the HPACCNA code book.

The SHBI code, in other words, is based on boiler output, while the recommendations of the HPACCNA are based on net load. But the SHBI permits one to calculate his required boiler size by adding net load to pipe losses; while the other includes an allowance for this factor.

### Hot Water Heating Boilers

As soon as one leaves the field of strictly low pressure steam heating, all semblance of rational bases of ratings seems lost. Consider, for instance, hot water heating systems, or again, high pressure boilers.

Both the SHBI code and R-157-35 translate the ratio of 17 to 1 for steam radiation to 27.2 to 1 for hot water radiation, because 240 and 150 represent the emission in Btu per hr per sq ft of steam and hot water radiation, respectively. But this emission rate was established for hot water radiation when 160 deg water was standard. In modern practice, forced circulation and much higher water temperatures are almost universally used. Hence, the ratio of 240 to 150 is meaningless today. The HPACCNA makes no direct recommendations on hot water systems, so far as net loads are concerned, but does give a formula for translating steam radiation to hot water, taking into account the operating water temperature. The Guide of the ASHVE has this to say on the subject in the 1939 edition:

> The unit, a square foot of equivalent direct radiation, EDR.... especially in hot water systems, has always resulted in complications and confusion. It is the plan of the Guide to eventually eliminate this empirical expression and to substitute a logical unit based on the Btu.

### High Pressure Boilers

In high pressure boiler practice the old nomenclature of boiler horsepower has been retained. Manufacturers of high pressure fire tube boilers, with few exceptions, base such capacities on 10 sq ft of surface per boiler hp. The exceptions occur, sometimes, in very small sizes, when 9 or 8 sq ft may be considered 1 boiler hp of capacity, and in some proprietary types of special boilers where 5 sq ft is called 1 boiler hp of capacity. But by far the majority of high pressure boilers are cataloged on the basis of 10 sq ft to the boiler hp.

Fundamentally, all bases of boiler ratings so far mentioned revert to the Btu. Those using square feet of steam radiation to express a boiler's rated output presuppose a ratio of 240 Btu per sq ft. Those using boiler horsepower to express capacities imply the 33,475 Btu required to evaporate 34.5 lb of water from and at 212 F. These facts lead to some peculiar arithmetical results. We cite an example, and refer in the comparisons to mechanically fired ratings—that is, the rating prevailing with a stoker, oil burner or gas burner under the boiler.

Consider the case of a standard riveted firebox boiler having 500 sq ft of heating surface, used in a small industrial plant where steam is required for processing, water heating, unit heaters and cast iron radiation. The total condensation averages 3100 lb per hr. Allowing 4.04 sq ft (970.2/240) per lb of condensate, the load is then equivalent to about 12,500 sq ft of radiation. The load in boiler horsepower is 3100/34.5 or 89.95. (Under actual conditions feed water and steam would hardly both be at 212 F, but for this example we can assume them to be.)

Under the SHBI code, 500 sq ft of heating surface gives the boiler a rating of 8500 sq ft EDR (500 × 17). It is therefore operating at 147 per cent (12,500/8500) of its rating. In the table published by the HPACCNA, the boiler has a rating of 6885 sq ft EDR; it is therefore operating at 181.5 per cent of its net load recommendation. If the boiler is built for and operates at high pressure, it has a rating of 50 boiler hp (500/10), and is therefore developing 180 per cent rating.

### Cast Iron Boilers

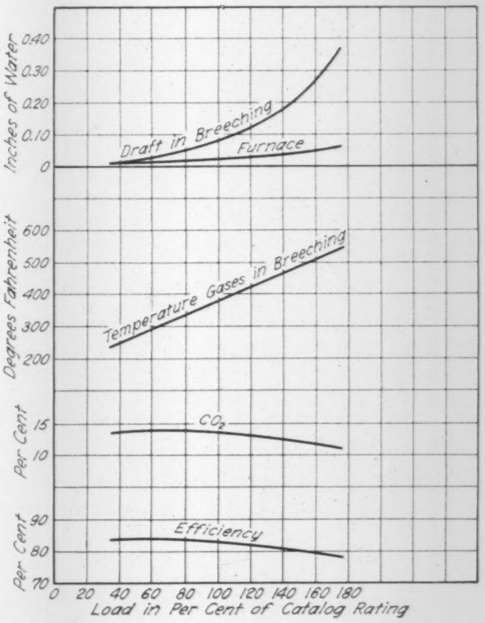
In taking up the question of cast iron boiler ratings, it is heartening to find that in the published data and rules of the Institute of Boiler and Radiator Manufacturers, which most manufacturers of cast iron boilers subscribe to, boiler ratings will be based on performance, without regard to boiler heating surface. The IBR is now engaged in a program that promises to clarify the entire subject of cast iron boiler capacities. Recently the first results of this program have been published, and were adopted by the manufacturer members, by the HPACCNA, and by most other firms and persons concerned. The HPACCNA deserves great praise for its work on this subject. For a number of years it has published dependable net load recommendations.

The IBR codes set up very rigid conditions for determining the output of a boiler. Under hand firing, the efficiency must be at least 58 per cent, the draft must be regulated to a prescribed basis, priming shall not exceed the point giving 2 per cent entrained moisture in the steam, and minimum firing periods are established. For oil firing or stoker firing, the stack temperature must not exceed 600 F and the $CO_2$ content of flue gases must not be less than 10 per cent. The IBR codes really represent a definite method of establishing a boiler's output capacity. Up to the present, they have been applied only to cast iron boilers not exceeding 20 in. grate width.

### Converting to Mechanical Firing

We have indicated the need for double checking on what is implied by a specification relating to boiler capacity on new installations. But what of the case when existing boilers are converted from hand firing to mechanical firing? Practically all boilers installed prior to 1930 carried a catalog rating entirely different from what will be shown today in the manufacturer's catalog for the same boiler. Are statements relating to capacity of these boilers to be interpreted on the basis of the original rating, or present day rating? And what stack conditions will be found in connection with such installations? Many cases arise where additions are made to existing plants. Figured on present day codes, the heating capacities of original boilers may come very close to the requirements of the combined load of the original building and the new addition. Perhaps the only limiting factors will be the combustion volume and the stack. The efficiency of a boiler does not drop off very rapidly with increase in load, but the draft loss through a boiler increases rapidly with increase in load. It might almost be said that the capacity of a boiler to absorb heat from the fire is limited only by the amount of heat that can be released in the firebox and the amount of gases that can be caused to move through the tubes.

The authors have specifically in mind a manufacturing plant where an interesting series of incidents occurred while the factory was expanding. The original plant, section A, was equipped with a steel heating boiler having about 400 sq ft of heating surface. Section B was erected in 1929, and was of about the same size as the first. A second boiler, identical with the first, was installed, and both boilers were then equipped with oil burners sized to carry about 6000 sq ft EDR each. It was found necessary to operate both boilers for normal heating. In 1935 section C was erected, equal again to the original section. A third and identical boiler was installed, but this time an oil burner was provided on the new boiler, with a capacity to carry 16,000 sq ft EDR, and a firebox was provided with corresponding combustion volume. It was found that the entire building could be heated in all except sub-zero weather with the new boiler and large burner. Clearly, the large burner could have been installed on either of the first two boilers, and the cost of the third boiler could have been saved.



**Performance curves for an oil fired steel boiler. Note that very little decrease occurs in efficiency by heavy overloading but that draft loss through the boiler increases five-fold from 80 to 160 per cent of boiler rating. This is important when designing chimneys for boiler plants which are expected to carry overloads**

The accompanying curves illustrate the points brought out in this discussion. They show the performance results on oil firing a certain steel heating boiler. The most important facts brought out are that very little decrease occurs in efficiency by heavy overloading, while the draft loss through the boiler increases five fold from 80 to 160 per cent of boiler rating. Engineers should keep this latter in mind when designing chimneys for boilers expected to carry overloads. It should be remembered that in general the friction loss through a given duct system varies as the square of the weight of gases handled.

# "OPEN FOR DISCUSSION"

## *Communications to the Editor*

### Avoiding Plant Shutdowns

The Editor—

Industrial plants engaged in the manufacture of defense and war material must be prepared for continuous operation, free from any delays. Frequently it is the little things that start the trouble which may cause a shutdown.

In order to avoid shutdowns and delays, a well kept up stock of supplies, tools and spare repair parts is important. This applies to the piping services, with the numerous valves, fittings and miscellaneous items used, as well as to other mechanical equipment, such as heating and air conditioning.

Welding equipment, for example, is essential in most plants for repairs and alterations. A suitable supply of the different sizes and kinds of welding rod for different requirements should be on hand. Flux and compounds are needed in some forms of welding; a few small cans of the different kinds is not an excessive stock, and are valuable when needed on short notice outside of regular business hours. Extra lengths of welding hose and cables for electric welding to reach to places not readily accessible are sometimes needed. Small fire extinguishers are handy when in the hurry up work of a repair job, sparks may start a fire. An assortment of tips for welding torches, so that the proper tip can always be used, not only helps the welder but shortens the time required for the welding.

Piping gaskets are of many different sizes and shapes. Standard gaskets should be kept on hand. Making gaskets of irregular shapes and dimensions in an emergency is usually a tedious and time consuming job. Manufacturers supply a small kit of cutters and punches which not only simplify it but enable making a gasket that fits properly.

Plastic compounds of different materials designed for many purposes are on the market and can be used to good advantage in piping work. Many a bad leak has been stopped by injecting plastic compound with a pressure gun in a leak without shutting off the pipe line. Shim material is needed when lining bearings and for various other uses. This material can be supplied in small cans containing a number of flexible strips of varying thickness, and is a great convenience when needed.

Among the many modern tools that piping men use to advantage is the ratchet handle and steel sockets, with extension bars, for removing and assembling bolts and nuts. These tools are a convenience and time saver in tightening flanged joints in the close places that seem to be inevitable in most piping installations. When time allotted for piping replacement and repairs is limited, it is quicker to cut off old rusty bolts with an acetylene torch and use bolt studs for re-assembling. The time saved will offset the cost of the new material.

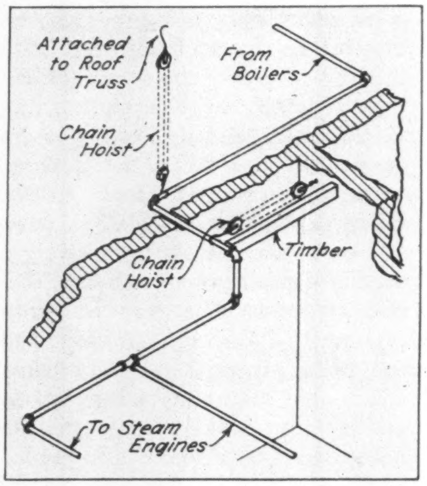
Automatic valves, regulators, governors and many other specialties should be installed with unions or flanges conveniently placed for disconnecting when necessary to examine the internal parts. It is not always necessary to remove the entire valve for examination or reseating but there are times when due to a leaking shut-off valve (or other causes, such as when the valve is near the ceiling or moving machinery) it is more convenient to take the valve to the work bench to make repairs.

Bearings for motors and machinery can cause troubles and delays to plant operation. Proper lubrication, frequent inspection and adjustment will help to maintain continuous service. Extra bearings should be kept on hand, marked for identification for each particular machine, so the proper bearing can be ready without delay. Lubricants for ball bearings are supplied in small cans; this keeps the grease clean for application.

Each plant has its own problems and the amount and variety of repair parts to keep on hand should be based on good judgment and past experience. A complete list of repair parts with sizes and catalog numbers will aid materially and expedite delivery when necessary to order them. A list or log of the important repair and maintenance jobs will help in maintaining service and aid in regular inspection work that will lessen the need for shutting down for repairs and will insure continuous plant operation.

**Readers of Heating, Piping and Air Conditioning are invited to contribute their views to these "Open for Discussion" pages, which will appear from time to time. Comments on articles we have published, expressions of timely interest on developments in design, installation, operation or maintenance of heating, piping or air conditioning systems, other remarks of value to HPAC's readers—all will be welcomed by The Editor.**

In addition to maintaining service and keeping the plant equipment in good condition, the operating personnel should be trained to make the best of conditions when occasion demands—in other words, to help themselves. For instance: The man in charge of a factory power plant was called at home on a holiday. The water heater, a large storage tank of No. 10 ga material, was leaking. As the heated water was used for manufacturing purposes it would be needed the next day. The boss went to the plant, and after removing some of the covering found that water (at 40 lb pressure) was coming through a small hole rusted through the metal. He picked up a small piece of wood, whittled out a pointed plug, drove it in the hole to stop the leak, and went home. It was some time afterward—several months—before authority was received to replace the old tank with a new one. In the meantime a few more wooden plugs were inserted in this tank as leaks developed.



**When the supports for an industrial plant steam line became loosened, allowing the piping to vibrate, emergency repairs were made by using two chain hoists secured to the structural steel work. A strain on each in opposite directions by means of the hoisting chains stopped vibration of the piping until permanent repairs could be made**

In another case, the wall bracket supports for a 12 in. steam main became loosened, causing the piping to shake and vibrate enough to warrant immediate attention. This was cared for temporarily by using two chain hoists secured to the overhead structural steel work of the building, taking a strain on each in opposite directions with the hoisting chains. This stopped the movement and vibration until permanent and lasting repairs could be made.—W. H. Wilson, Member of HPAC's Board of Consulting and Contributing Editors.

## Designing a Duct

The Editor—

Relative to the letter of Gordon Midboe on p. 544 of the September Heating, Piping and Air Conditioning regarding the duct of constant cross sectional area and constantly decreasing air volume and air velocity, there are two things to bear in mind in the construction of such a duct:

1) The friction loss for the run of duct must be kept as low as possible. The shock loss due to decreasing air velocity is negligible.

2) Discharge velocity through nozzles or slots must be high, so as to maintain a relatively high discharge pressure.

There is a static pressure regain approximately equal to the difference between velocity pressure at the start of the duct and the velocity pressure at the end of the duct. The net pressure regain is equal to static pressure regain minus the resistance pressure for the run of duct.

There is an empirical formula for calculating the friction loss through these ducts and also one for calculating the horizontal throw of air in feet.

Due to the static pressure gain at the end of the duct, and also due to the fact that ample velocity pressure is available at the start of the duct for conversion to discharge pressure, the static pressure maintained in the first part of the duct will be less than that in the latter part.

If trouble is found in balancing such a duct, the slots or nozzles at the start of the run can be made smaller so as to increase the discharge resistance, and the nozzles toward the end made larger. —F. F. Stevenson, Air Comfort Corp.

## Cost of Factory Heating

The Editor—

I am looking for information on the approximate installation costs of heating systems in factories of about 300,000 sq ft floor area in the New England area. —R. H.

The Editor—

In reply to the above, it is very difficult to name an approximate cost for a heating plant for an unseen factory, as so much depends on the ceiling height, character of roof and amount of glass. Very roughly 25c per sq ft of floor might cover the boilers, combustion appliances, chimney, unit heaters, piping, automatic control and pipe insulation.

I designed an oil burning steam boiler, vacuum circulation, unit heater factory job in Boston a couple of years ago which was contracted for at considerably less than 25c per sq ft of floor.—Samuel R. Lewis, Consulting Mechanical Engineer, Member of HPAC's Board of Consulting and Contributing Editors.

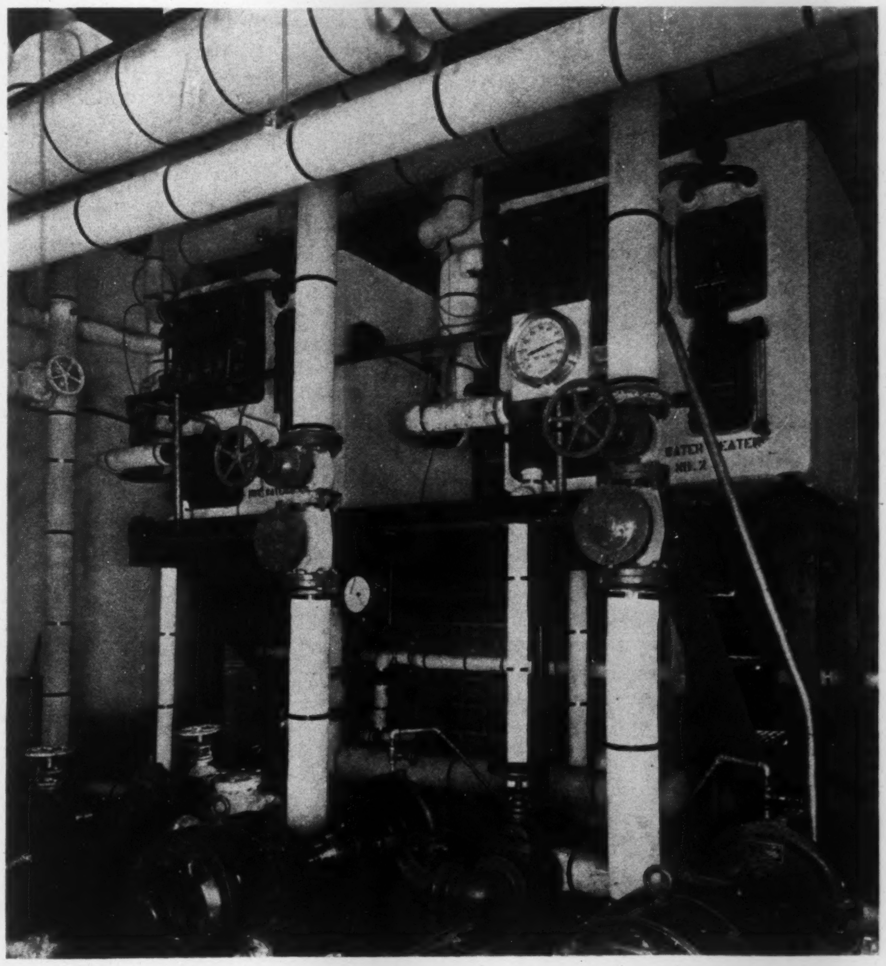
## Deaerating Heaters at Hospital

The Editor—

The two deaerating heaters shown in the accompanying picture are installed to remove dissolved oxygen and heat domestic service water at the Harrisburg state hospital, Harrisburg, Pa. The No. 2 heater (right) is the original unit furnished in 1930. This heater, moved from the old power plant to its present location, and the new heater (left) each have a capacity of 48,000 lb per hr.

The two pumps in front of the heaters are the hot water circulating pumps. At the time the picture was taken, water was leaving the heaters at an average temperature of 170 F as shown by the recorder under the new heater, and was being discharged into the system at approximately 80 lb pressure according to the pressure gage between the two heaters.—Irvin H. Geiger, Cochrane Corp.

**These two deaerating heaters are installed to remove dissolved oxygen and to heat domestic service water at the Harrisburg, Pa., state hospital**



## Air Conditioned Brooms

The Editor—

Brooms suffer from the effects of humidity. In humid summer weather, newly manufactured brooms readily develop mildew and become discolored from atmospheric moisture. That was the experience of the Ace Broom Co., Brooklyn, N. Y., until the recent installation of new gas air conditioning equipment. Brooms, after fabrication, are placed in a storeroom which is ventilated with dry air from a gas fired silica gel dehumidifier supplying 600 cfm of dehumidified air.

According to the owner, since this equipment has been in operation, neither time nor material have been lost because of adverse weather conditions, and production has shown that the unit will shortly pay for itself.—James M. Connolly, Brooklyn Union Gas Co.

# A Large or Small Temperature Rise Through Water Type Cooling Coils?

## F. F. Stevenson* Analyzes the Question of the Proper Water Temperature Rise to Use in Air Conditioning System Design

COOLING air by means of circulating chilled water is an important method of air conditioning. Chilled water is an ideal medium for cooling particularly when the air conditioning system includes a number of zones each with its own coil bank and fan, or where the system comprises a number of separate units; water is easy to handle and control and is comparatively immune from leakage troubles. Another advantage is that the same coil sections and pipe lines used for cooling may also be used for hot water heating in winter by providing the necessary connections and valves.

### Two Schools of Thought

In using chilled water for air cooling, two schools of thought have developed among designers and engineers; one recommends a comparatively small water temperature rise through the coils, using large quantities of water, while the other advocates the use of less water, with a high temperature rise through the coils. Choosing one or the other of these methods involves important decisions in the design of the system. (Plants using city water or well water for cooling do not come under the scope of this discussion, for in these cases the system must be planned in accordance with the quantities and temperatures of water available and is frequently designed to operate with a minimum of water. We are concerned here with plants where the water is artificially chilled and recirculated.)

Let us assume we wish to determine the relative merits of a system using an 8 F water temperature rise through the coils (System No. 1) and one using a 16 F water temperature rise through the coils (System No. 2.) With System No. 1, we shall need 3 gpm of water per ton of refrigeration effect, and with System No. 2 we shall need 1½ gpm.

### Water Velocity Through Coil

Water velocity through the coil has an important effect on the internal film coefficient of heat transfer, which in turn affects the over-all heat transmission rate. However, by using the proper style of coil, we can arrange to have approximately the same water velocity in each system, notwithstanding the fact that one system uses twice as much water as the other.

For System No. 1 we shall use a coil built so that the water supply header feeds two vertical stands of tubes simultaneously. In other words, with respect to rows of tubes deep, the first and second rows are fed directly from the header. If the coil bank is four rows in depth, then there are two water passes; if six rows deep, three water passes. The total water supply is divided in half, one half going through the first vertical stand of tubes and the other half passing through the second stand of tubes.

**SUMMARY**

**Cooling air by circulating chilled water through coils is an important method of air conditioning. Two schools of thought have developed among designers and engineers in regard to the proper water temperature rise through the coils—high or low—and the choice involves important decisions in connection with the system design. . . . The factors which must be given consideration include water velocity in the coils, the mean temperature difference (MTD), surface temperatures of the coils, how much of the coil surfaces will be dry, water pressure drops, suction conditions for the refrigeration machine, pumping costs, etc. The author briefly compares these items for two systems, one using an 8 F rise and the other a 16 F rise. . . . A second article will be devoted to the water chillers for the two systems**

System No. 2, with just half the water volume, uses a coil with the header supplying water to one vertical stand of tubes. With this coil, if it is four rows in depth, there are four water passes. Assuming that each coil is the same number of tubes high, we see that equal quantities of water are fed to each circuit and the water velocity is approximately the same in each case. Therefore, from the standpoint of the internal film coefficient of heat transfer, there should be little difference between the two systems.

### Mean Temperature Difference

It is another matter, however, when we consider the mean temperature difference (MTD) between the air and the water. Disregarding water temperature losses or gains in lines, let us assume that we have water available at 45 F. In System No. 1, the water will leave the coil at 53 F and in No. 2 at 61 F. Thus the MTD for System No. 1 will be greater than for No. 2. A number of tests under average operating conditions show that with the calculated variation in MTD, System No. 2 will require approximately 25 per cent more coil surface than No. 1 to handle the same cooling load. In other words, if No. 1 needs a coil four rows deep, No. 2 will require five rows. Recent tests have also shown that the MTD has an effect on the external coefficient of heat transfer (air to coil surface film); as the MTD increases, the value of this coefficient is also higher. There is little authoritative data on this subject, however.

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*Air Comfort Corp.

There will be a considerable difference, also, in the effective surface temperature of each coil. With load and air velocity remaining constant, the average over-all surface temperature of any coil will rise as the water temperature rises.

### Ratio of Specific Heats

Another factor to consider at this point is the ratio of the specific heats[1] of the two masses of fluids used in these systems. In counterflow cooling work, the ratio of the specific heat of the mass of warm fluid (the air) per hour, to the specific heat of the mass of cool fluid (the water) per hour, should be less than one. If this be true, the wet bulb temperature of the leaving air tends to approach the temperature of the entering water. On the other hand, if the ratio is more than one, the water tends to leave the coil at a temperature approaching the wet bulb temperature of the entering air.

Let us check this in Systems No. 1 and No. 2. Assume a four row coil with a face area of 1 sq ft, and air passes through it with a face velocity of 500 fpm. Assume that we are cooling the air, whose entrance condition is 84 F dry bulb, 70 F wet bulb and 63 F dew point, to a leaving condition of 63 F dry bulb, 60.5 F wet bulb and 59.3 F dew point. The total load will be 15,150 Btu per hr. System No. 1 will use 3.8 gpm of water to handle this load and the specific heat of the mass of water flowing through the coil per hour is $3.8 \times 60 \times 8\frac{1}{3} = 1900$ Btu. The specific heat of the mass of air passing through the coil per hour is $500 \times 1.04 = 520$ Btu.[2] The ratio of the specific heat of the mass of warm fluid to the specific heat of the mass of cool fluid for System No. 1 is therefore $520/1900 = 0.27$.

System No. 2 will use 1.9 gpm of water to handle the same load and the specific heat of the mass of water flowing through the coil per hour is 950 Btu. The ratio for System No. 2 is therefore $520/950 = 0.55$. The ratio for System No. 1 is therefore more favorable.

### Surface Temperatures of Coils

Let us now consider the surface conditions of the two coils, which have an important bearing on both the sensible and latent cooling work done by them. Are the surfaces entirely wet or are they partly wet and partly dry? In System No. 1, the water enters the coil at 45 F and leaves at 53 F. The entering air has a dew point of 63 F. With the leaving water temperature of 53 F, and normal operating conditions, we can expect practically the entire coil surface to have a temperature below the dew point of the air so that dehumidificaton will occur over the entire coil.

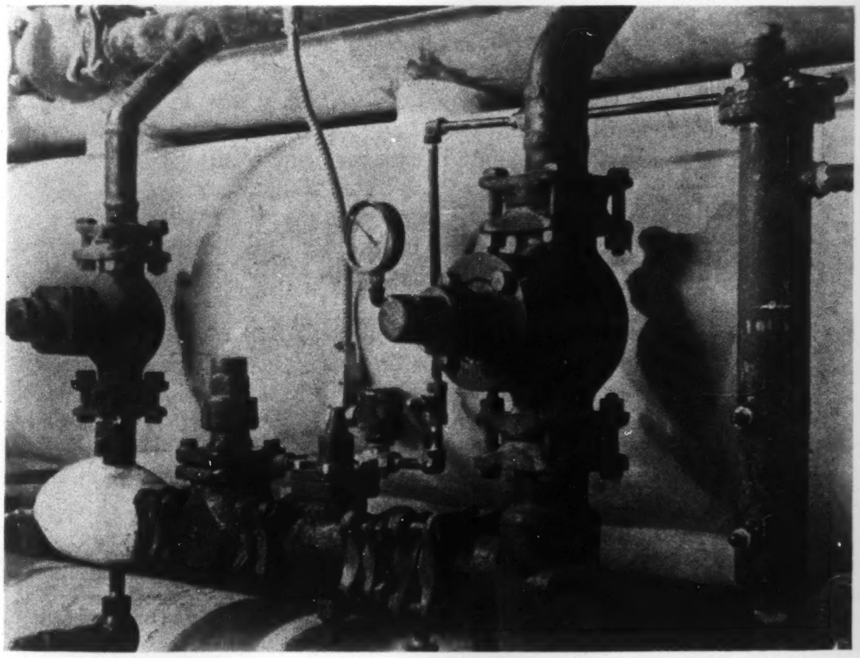
In System No. 2, the water enters the five row coil at 45 F and leaves at 61 F. Goodman offers a method of ascertaining what he calls the "boundary dry bulb temperature" of a coil operating with various loads and temperatures. If the initial dry bulb temperature of the air is higher than the computed boundary line temperature, part of the coil surface will be dry; if lower, the entire coil will be wet. This is explained in Mr. Goodman's article Performance of Coils for Dehumidifying Air, HEATING, PIPING AND AIR CONDITIONING, November, 1938—May, 1939, and particularly on pp. 779-780, December, 1938, issue.

Using this analysis for System No. 2, it will be found that a considerable portion of the coil surface would be dry and no dehumidification would occur on this surface. Under average conditions it would seem that the coil of System No. 2 would not be a good dehumidifier. It is therefore important to check the latent performance of a coil when the rise in water temperature is high.

### Other Considerations

Another consideration in the merits of the two systems is the water pressure drop through the coils. Here System No. 1, with its shorter water circuits, will have an advantage, especially if the coil is large.

To avoid the objectionable factors of System No. 2, it is of course obvious that the MTD and the dehumidifying effect can be increased by decreasing the temperature of the entering water and maintaining the same water rise. Reducing the temperature of the entering water to 41 F, with a 16 deg rise, gives an MTD close to that of System No. 1. In this way, the disadvantages of additional surface requirements, insufficient latent heat capacity and higher water pres-



**Control valves of a "Freon" water chiller. At right can be seen the liquid level float. This controls amount of liquid in the small "feeler" line running to left. A power piston valve (lower center) controls the flow of refrigerant to shell. This valve has a modulating action, actuated by the amount of pressure at the top of the valve, which pressure is transmitted by the "feeler" line**

Courtesy of H. A. Phillips & Co.

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[1] By the specific heat, the author means the heat required to change the temperature of the mass of air or water flowing 1F.

[2] It requires 1.04 Btu per hr to change the temperature of the mass of air flowing at a rate of 1 cfm, 1F.

sure drop through the coil disappear, but another one makes its appearance—refrigeration machine operation. Requiring the machine to operate at a suction temperature several degrees less than originally planned will increase power cost per ton. Also, if in sizing the machine we have a "border line" case where it might have just enough capacity at the original suction condition, the effect of decreasing suction temperature several degrees might lower capacity to an extent that we should have to install the next size larger machine. In a large system, this might mean quite an expenditure.

The average air conditioning system works most of the time at loads considerably less than the design peak and the competent engineer designs his system so that it will operate efficiently and economically at 50 to 75 per cent of the design peak. In systems using water coils, when the load falls off we can decrease the capacity of the system by (1) increasing the coil water temperature, by recirculating part of the return, or (2) cutting off certain sections of the coil bank, by means of automatic or manual control devices. In either case, especially with reduced load, with a high ratio of latent heat, System No. 1 should be more efficient, for its leaving water temperature is lower and its lower surface temperature makes it a better dehumidifier, even when the entering water temperature is increased considerably.

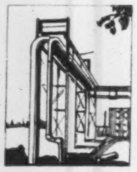
To sum up, our analysis shows that with respect to the cooling coil, System No. 1 with the low water rise is apparently preferable.

Turning now to a comparison of pipe lines and water pumps, System No. 2, using half of the quantity of water, has an advantage. With regard to the piping, however, this may not mean much in dollars and cents, unless the system is a large one with long runs. In the comparison of water pumps, the saving in the pump cost for System No. 2 may not be as large as the necessary expenditure for the additional coil surface required.

[*A second article will be devoted to the water chillers for these two systems.*]

# ASTM Committee Reports New Specifications

Quite a number of papers and reports presented at the 1940 annual meeting of the American Society for Testing Materials—held in Atlantic City last June—pertained to the field of ferrous materials. The extensive report of the society's committee A-1 on steel included five new tentative specifications—one on factory made wrought carbon steel and carbon molybdenum steel welding fittings and four covering carbon and alloy steel forgings respectively for general industrial and for railroad use, providing various grades of material classified by size and by heat treatments to provide the required physical properties.



A number of other actions were taken at the steel committee meetings amplifying its report. One involved the clarification of the use of the steel plate specifications (A78) in connection with the fabrication of pipe—this grade of low tensile steel of structural quality for welding is widely used for fusion welding. Of particular interest in the oil refinery field was the addition of requirements for upset ends of tubes and repair by grinding, in the three specifications for carbon and alloy still tubes.

Standardized requirements for hardness testing of boiler and superheater tubes were also effected classifying the material on which the Brinell and Rockwell tests are to be used. Five specifications in the boiler and superheater field which have existed as tentative were to be referred to society ballot for adoption as standard, this action having had the approval of the annual meeting even though it was not included in the preprinted committee report. An important change in the report involved the specifications for forged or rolled pipe flanges, valves, etc. which limits the carbon to 0.35 per cent when subject to fusion welding and refers to the addition of silicon.

One of the items approved in the report was the incorporation of a new grade of high strength boiler rivet with a tensile strength of 58,000-68,000 psi and yield point of half the tensile strength but in no case less than 32,000 psi. This compares with the existing standard boiler rivet grade of 45,000-55,000 psi tensile.

The steel committee also acted to approve the appointment of two new service or coördinating committees, one in the field of heat treatment and the other on welding so that consideration can be given to the various requirements for groups of materials such as forgings, pipe, castings and the like.

The committee on iron-chromium-nickel and related alloys reported definite progress in its compilation of data including chemical analysis, mechanical properties, heat treatment, etc. of stainless steels. It is expected this information will be published during the year.

In his presidential address, H. H. Morgan, Robert W. Hunt Co., stated that the important specifications are standards of trade and that standardization has been the bedrock of civilization. He pointed to some of the specific advantages of using good specifications, as follows: (1) they enable the buyer to get what he wants; (2) the material is of uniform quality; (3) the buyer receives goods more quickly and with less trouble; (4) he has access to wider markets; (5) costs are lower; (6) a suitable acceptance basis is established; (7) material becomes standardized, and (8) research is promoted.

Mr. Morgan stressed the fact that the practical importance of specifications hinges directly on their ability to assure the buyer that he is receiving exactly the goods he orders. In the competition of trade, particularly in regard to heavy products under mass production, it is essential to know that materials are furnished according to specifications, he said.

# Piping Flow Problems Made Easy

## William Goodman* Presents Single Chart for Determining Pressure Drop, Pipe Size or Rate of Flow for Any Fluid

CHARTS for sizing piping systems are widely used because of their convenience; however, separate ones are usually required for each different fluid. Fig. 1 eliminates the need for separate charts because it can be used for any fluid, whether liquid or gas, as long as the flow is turbulent and not streamline. It can be used for water, steam, air, brine, ammonia—in short, for any fluid whose density and viscosity are known. The chart can be used not only to size pipe for a given rate of flow and pressure drop, but also to determine the rate of flow for a given pipe size and pressure drop or the pressure drop for a given pipe size and rate of flow.

### Criterion for Turbulent Flow

Reynolds' number computed by Equation 1 determines whether the flow will be turbulent or streamline. If Reynolds' number is greater than approximately 2000, the flow will be turbulent and Fig. 1 may be used for the solution of the problem. If it is less than 2000, the flow is likely to be streamline and Fig. 1 should not be used. Except for oil, the flow is turbulent for most of the cases encountered in commercial engineering work.

$$Re = 378.8 \frac{W}{Du} \quad \ldots\ldots\ldots\ldots\ldots\ldots [1]$$

### Description of Chart

Fig. 1 consists of two parts: the scales of diameter, pressure drop and weight are on the left side and the scales of density and viscosity are on the right. To use the chart for a particular fluid, enter the right side at the density of the fluid as at *A* of Fig. 2. Find the point *B* where the vertical line through *A* intersects the diagonal line representing the viscosity of the fluid. The horizontal line *BH* drawn through *B* represents the particular fluid on the left side of the chart and this one particular line is used for all problems involving that particular fluid.

A few examples will show the use of the chart. Example 1 illustrates its use for finding the pipe size for a given pressure drop for two such different fluids as water and ammonia vapor.

**Example 1:** Find the size pipe needed for a flow of 500 lb per min and a maximum pressure drop of 0.5 lb per sq in. per 100 ft of pipe length if (a) the fluid is water at 68 F. (b) the fluid is saturated ammonia vapor at 45 F.

*Solution:* (a) For water at 68 F, density $d = 62.3$ lb per cu ft and viscosity[1] $u = 1$ centipoise. The method of using Fig. 1 to find the pipe size is illustrated in Fig. 2.

Enter the chart at point *A* for a density of 62.3 lb per cu ft. Locate point *B* where the vertical line through the density of 62.3 intersects the diagonal viscosity line of 1 centipoise.

Now enter the chart at *C* for a flow of 500 lb per min. Extend a vertical line through *C* until it intersects at *D* a horizontal line drawn through *B*. The pipe size for various pressure drops can now be read along the diagonal directrix line *DF* through point *D*.

Enter the chart at point *E* for a pressure drop of 0.5. Extend the horizontal line through *E* until it intersects the diagonal directrix at *F*. Drop down vertically from *F* to the pipe size scale and read 3 in. as the internal diameter of the pipe required.

To check whether Fig. 1 is applicable to this problem, substitute the numerical values of this example into Equation 1.

$$Re = 378.8 \times \frac{500}{3 \times 1} = 63{,}130$$

b) For saturated ammonia vapor at 45 F, density[2] $d = 0.28$ lb per cu ft and viscosity $u = 0.01$ centipoise. Again Fig. 2 serves as a guide for using the chart of Fig. 1.

Enter the chart at point *A* for a density of 0.28 lb per cu ft. Locate point *B* where the vertical line through the density of 0.28 intersects the diagonal viscosity line of 0.01 centipoise.

Now enter the chart at *C* for a flow of 500 lb per min. Extend a horizontal line through *B* until it intersects the vertical line of 500 lb per min at point *D*. The pipe size for various pressure drops can now be read along the diagonal directrix line *DF* through point *D*.

Enter the chart at point *E* for a pressure drop of 0.5 lb. Extend the horizontal line through *E* until it intersects the diagonal directrix at *F*. Drop down vertically from *F* to the pipe size scale and read 8 in. as the internal diameter of the pipe required.

To check whether Fig. 1 is applicable to this problem, substitute the numerical values of this example into Equation 1.

$$Re = 378.8 \times \frac{500}{8 \times 0.01} = 2{,}368{,}000$$

### Finding Pressure Drop

Once familiarity with the chart is acquired, not only the pipe sizes but a great variety of piping flow problems

SUMMARY

**Because of their convenience, charts are widely used for sizing piping systems. Fig. 1, presented here, eliminates the need for a separate chart for each fluid as it is based on Reynolds' numbers and is universal in scope as long as the flow is turbulent and not streamline. This may be determined by a simple equation, and except for oil, flow is turbulent for most of the cases encountered in commercial engineering work . . . The chart can be used not only to size a pipe for a given rate of flow and pressure drop, but also to determine the rate of flow for a given pipe size and pressure drop, or the pressure drop for a given pipe size and rate of flow . . . A particularly helpful use of the chart is in quickly determining the pressure drop for several different pipe sizes**

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*The Trane Co. Member of HPAC's Board of Consulting and Contributing Editors.

Copyright, 1940, by William Goodman.

[1] All values of viscosity used in this article are from Figs. 2 and 2a on pp. 628 and 629 of the October, 1937, HEATING, PIPING AND AIR CONDITIONING.

[2] From Bureau of Standards Circular No. 142.

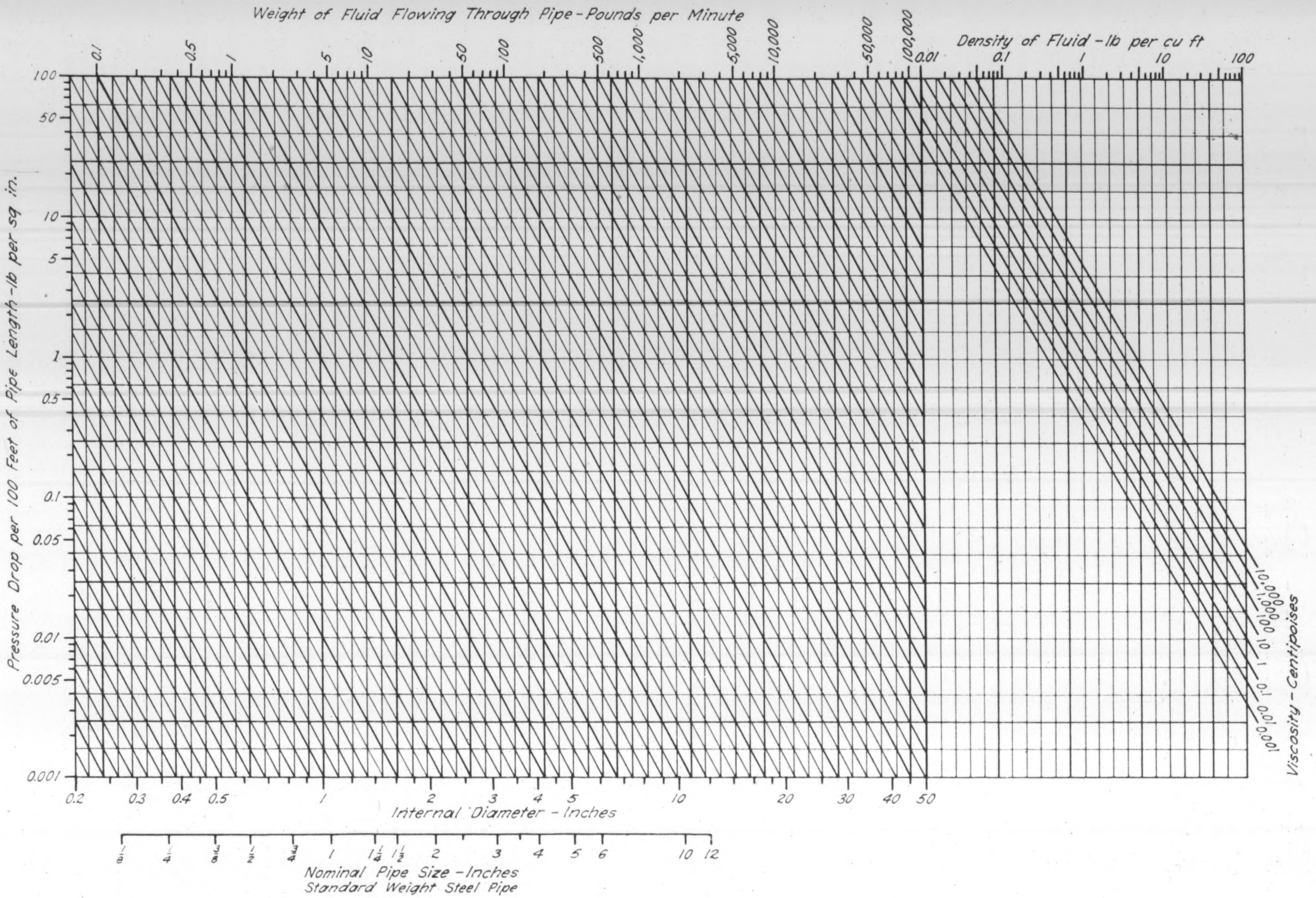

**Fig. 1—Universal chart for fluids in turbulent flow for determining pressure drop, pipe size, or rate of flow**

[For clean commercial steel or cast iron pipe. For clean copper pipe the pressure drop will be lower than that obtained from this chart. Consequently, the chart may be safely used for copper pipe.]

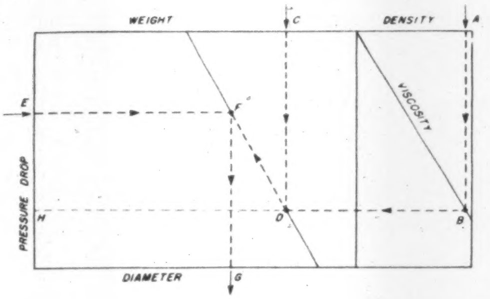

**Fig. 2—Skeleton chart showing how Fig. 1 is used for determining either pressure drop or pipe size**

can be solved. The following example illustrates the method of using the chart to find the pressure drop for a given pipe size and flow.

**Example 2:** Compressed air is flowing through a pipe of 4 in. inside diameter at the rate of 75 lb per min. The air has a density of 0.48 lb per cu ft and a viscosity of 0.019 centipoises. Find the pressure drop.

*Solution:* Fig. 2 serves to illustrate the use of Fig. 1.

Enter the chart at point *A* for a density of 0.48 lb per cu ft. Locate point *B* where the vertical line through the density of 0.48 lb per cu ft intersects the diagonal viscosity line of 0.019 centipoises.

Now enter the chart at *C* for a flow of 75 lb per min. Extend a vertical line through *C* until it intersects at *D* a horizontal line drawn through *B*. Locate the diagonal directrix line through point D.

Now enter the chart at *G* at an internal pipe diameter of 4 in. and extend a vertical line up until it intersects the diagonal directrix line *DF* at point *F*. Extend a horizontal line through point *F* and read a pressure drop of 0.27 lb per sq in. per 100 ft of length at point *E*.

To check whether Fig. 1 is applicable to this problem, substitute the numerical values of this example into Equation 1.

$$Re = 378.8 \times \frac{75}{4 \times 0.019} = 373{,}800$$

In selecting pipe sizes, it is frequently of help to be able to determine quickly the pressure drop for several different size pipes. When this is done, it will usually be found that above a certain size the pressure drop decreases very slowly so that there is no advantage in going above this size. To determine the pressure drop for several different pipe sizes, it is necessary only to read the pressure drop where each vertical line of pipe size intersects the directrix *DF* of Fig. 2. The same sloping directrix determined by the density, viscosity and rate of flow is used for all of the different size pipes.

As an illustration, for the conditions of Example 2, the pressure drops listed below were determined for several different size pipes; all of these were read along the same sloping directrix *DF:*

| Pipe Size, In. | Pressure Drop, Lb per Sq In. per 100 Ft |
|---|---|
| 2 | 7.5 |
| 3 | 1.1 |
| 4 | 0.27 |
| 5 | 0.09 |
| 6 | 0.037 |

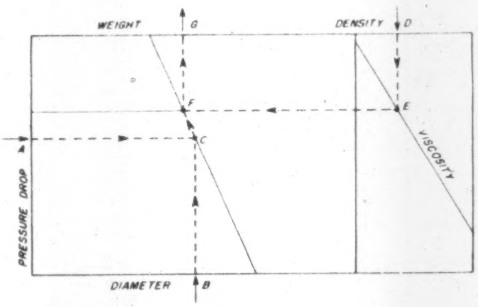

**Fig. 3—Skeleton chart showing how Fig. 1 is used for determining the weight of fluid that will flow through a pipe of given size for a given pressure drop**

## Rate of Flow Through Pipe Line

Fig. 1 can also be used to determine the rate of flow through a given size pipe for a given pressure drop. Example 3 illustrates this.

**Example 3:** The pressure drop through a pipe line of 3 in. internal diameter is not to exceed 0.1 lb per 100 ft of pipe length. Find the maximum flow in the pipe line if the fluid is (a) saturated steam at 300 F. (b) calcium chloride brine of 1.2 specific gravity at a temperature of 60 F.

**List of Symbols**

*D* = pipe diameter, in.

*d* = density of fluid, lb per cu ft

*f* = friction factor

*L* = equivalent length of pipe, ft (includes losses due to fittings, and entrance and exit losses)

*p* = pressure drop in pipe line, lb per sq in. per 100 ft of pipe length

*Re* = Reynolds' number

*u* = viscosity of fluid, centipoises

*W* = weight of fluid flowing through the pipe, lb per min

*Solution:* Fig. 3 serves to illustrate the method of using Fig. 1 for solving a problem of this type.

a) For saturated steam at 300 F, density[3] $d = 0.155$ lb per cu ft. Viscosity[1] $u = 0.015$ centipoise. Enter Fig. 3 at point *A* for a pressure drop of 0.1 lb per 100 ft. Also enter at point *B* for an internal pipe diameter of 3 in. The vertical line through *B* and the horizontal line through *A* intersect at point *C*, locating *CF*, the diagonal directrix through point *C*.

Now enter the chart at point *D* at a density of 0.155. Locate point *E* where the vertical line through *D* intersects the diagonal viscosity line of 0.015 centipoise. Extend a horizontal line through *E* until it intersects the diagonal directrix line *CF* at point *F*. Draw a vertical line through point *F* and read at point *G* a flow of 11 lb per min of steam.

To check whether Fig. 1 is applicable to this problem, substitute the numerical values of this example into Equation 1.

$$Re = 378.8 \times \frac{11}{3 \times 0.015} = 92{,}590$$

b) Density *d* of 1.2 specific gravity calcium chloride brine is $62.3 \times 1.2 = 74.8$ lb per cu ft. Viscosity[1] $u = 2.4$ centipoises.

Use the same directrix line *CF* in Fig. 3 as was previously located in part (a) of this example. Enter the chart of Fig. 3 at point *D* for a density of 74.8 lb per cu ft. Drop a vertical line from point *D* until it intersects the diagonal viscosity line of 2.4 centipoises at point *E*. Draw a horizontal line through point *E* until it intersects the diagonal directrix line *CF*. From the point of intersection draw a vertical line up to the flow scale and read at *G* a flow of 205 lb per min of brine.

To check whether Fig. 1 is applicable to this problem, substitute the numerical values of this example into Equation 1.

$$Re = 378.8 \times \frac{205}{3 \times 2.4} = 10{,}790$$

From the examples given here, it is evident that the chart of Fig. 1 is versatile and can be used to solve practically any type of turbulent flow problem involving any fluid whose density and viscosity fall within the range of scales given on the chart.

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[3] From Keenan and Keyes steam tables.

### Basis of the Chart

The chart has been drawn for commercial pipe from the following formula:

$$p = 0.0007843 \frac{u^{0.17}}{d} \frac{L}{D^{4.83}} W^{1.83} \ldots\ldots\ldots\ldots [2]$$

This equation is obtained from the basic Fanning[1] equation:

$$p = 0.01209 \frac{f}{d} \frac{L}{D^5} W^2 \ldots\ldots\ldots\ldots [3]$$

The value of the friction factor *f* is represented by the following equation:

$$f = \frac{0.178}{Re^{0.17}} \ldots\ldots\ldots\ldots [4]$$

Substituting Equations 1 and 4 into 3, Equation 2 is obtained.

Equation 4 gives values of the friction factor *f* that are higher than those obtained from the curve marked *A* in Fig. 1 on p. 626 of the October, 1937, HPAC for all values of Reynolds' numbers from 6000 to 1,000,000. For values of Reynolds' numbers between 2000 and 6000 and for Reynolds' numbers between 1,000,000 and 2,500,000, the friction factors given by Equation 4 are slightly lower than those obtained from this curve. However, Equation 4 can safely be used for values of Reynold's numbers as low as 2000, which is the lower limit for turbulent flow. It can also be used for the values of the Reynolds' numbers as high as 2,500,000 without serious error. The reason for this is that the above-mentioned curve is derived from experimental data of Drew, Koo and McAdams[4] and represents the average value of a large number of experimental points which plot as a band rather than as a single line on the chart. The straight line represented by Equation 4 plots within or slightly over the band, and for most of the range is on the safe side.

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[4] Drew, Koo & McAdams, Transactions, American Institute of Chemical Engineers, Vol. 28, 1932, pp. 56-72.

# Man's Love of Round Numbers

Strange as it may seem, we like some numbers so well, and we dislike other numbers so much, that these likes and dislikes have made indelible marks in the world of affairs.

They have an important—sometimes a controlling—influence in standardization matters. The development of an American Standard on rounding off numerical values makes a discussion of these matters timely.

We have a kindly feeling for numbers ending in 0 or 5; for example, they come out even when we count them on our fingers. We think of 10, 40, 50, 75, 100, and 1,000 as *nice* numbers. Even numbers are *nicer* than odd numbers. We say 6 or 8, 10 or 12, 30 or 40, 50 or 100, *not* 7 or 9, *not* 11 or 13, *not* 29 or 41, *not* 51 or 99.

One reason we like an even number better is that we can take half of it without bothering with fractions.

That in turn is the reason we like *small* numbers. We can master them and play with them with little effort. This is especially true of the first ten digits.

We have an unfriendly feeling toward prime numbers generally; 17—23—37—43—59—67 are forbidding just because they are indivisible. They make us feel discouraged because we can do so little with them. On the other hand we have a friendly feeling for numbers like 12—16—20—24—36—60—64, which can be reduced to the simple factors 2—3—5. Especially do we like those having symmetry, like 36. The powers of 2 are especially *nice* and the fractions ¾, ¼, ⅛, etc. partake of this attractiveness.

A striking illustration of our love of simple round numbers is to be found in the use of nominal sizes. An example is in pipe diameters. The following dimensions are typical of the pipe diameters of the smaller sizes:

| | Actual Diameters | |
|---|---|---|
| Nominal Size (in inches) | Inside (in inches) | Outside (in inches) |
| ⅛ | 0.269 | 0.405 |
| ½ | 0.622 | 0.840 |
| 1 | 1.049 | 1.315 |

It will be noted that the ⅛ in. pipe is more than ¼ in. in inside diameter.

There are many fields in which there is need of a series of sizes of a product, such as rods of different diameters, sizes of structural steel, frying pans, pumps, electric motors, bolts and nuts, and nails.

Our human preference for simple, whole numbers naturally leads to the selection of round numbers for the series of sizes. It is obvious, however, that in large scale production important economies may result from the selection of the best possible sizes and best possible spacing between sizes. This calls for a science of sizing applicable to series of sizes. A start has been made toward such a science through the development of a series of "Preferred Numbers." This series has been adopted by the national standardizing bodies of a number of countries, including the American Standards Association. The series provides five basic steps between 10 and 100, *viz:* 10, 16, 25, 40, 63, 100. This is known as the "5-Series." These, together with five intermediate steps provide a "10-Series" where closer spacing is called for. Additional intermediate steps provide a "20-Series" and a "40-Series."

This series represents a carefully worked-out compromise between the human desire for extremely simple, round numbers and the engineering aspects.

For example, from the standpoint of simple numbers alone, equal spacing, using even integers; *e.g.* 8, 10, 12, 14, 16, etc. has often been used. An early published

[*Concluded on p.* 614]

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Abstracted from an article by P. G. Agnew, secretary of the American Standards Association, which appeared in Industrial Standardization, publication of the ASA. The ASA has recently issued Rules for Rounding Off Numerical Values.

# Modern Heating and Ventilating

## . . . . . under complete automatic control features this new school described by Meryl L. Todd, Consulting Engineer

SUMMARY

The Longfellow elementary school, Waterloo, Iowa, is a strictly modern building costing approximately $350,000. It was built to replace two or three obsolete grade schools and includes about 28 classrooms, an auditorium, gymnasium and offices, accommodating about 1000 students. The two story structure is approximately 300 ft long, enclosing about 797,365 cu ft. . . . Every effort was made to coördinate the heating and ventilating system and to make it as modern as the building itself. It was designed for complete automatic control of the temperature, quantity and quality of the air within the building. The entire system was zoned to maintain a definite standard of air quality throughout the building with a maximum of operating economy. Conditioned air is admitted into each classroom upward along the outside walls, the temperature being controlled by individual room thermostats. . . . The design of the boiler room and equipment spaces, limited by site conditions, took into consideration space and appearance. All equipment and material, with the exception of those pieces requiring regular observation or attention, were either partially or completely concealed. There is complete automatic continuity of coal flow from the storage bins to the stoker hoppers, and from there into either or both boilers, as determined by the automatic control

THE heating and ventilating system for the Longfellow elementary school, Waterloo, Iowa, is of modern design. It consists essentially of an automatically operated boiler room and a zoned central heating and ventilating system, complete with temperature control.

### Boiler Room Is Water Tight

The boiler and equipment rooms are approximately 12 ft below the ground level, and because of possible flood conditions are of specially designed water tight construction.

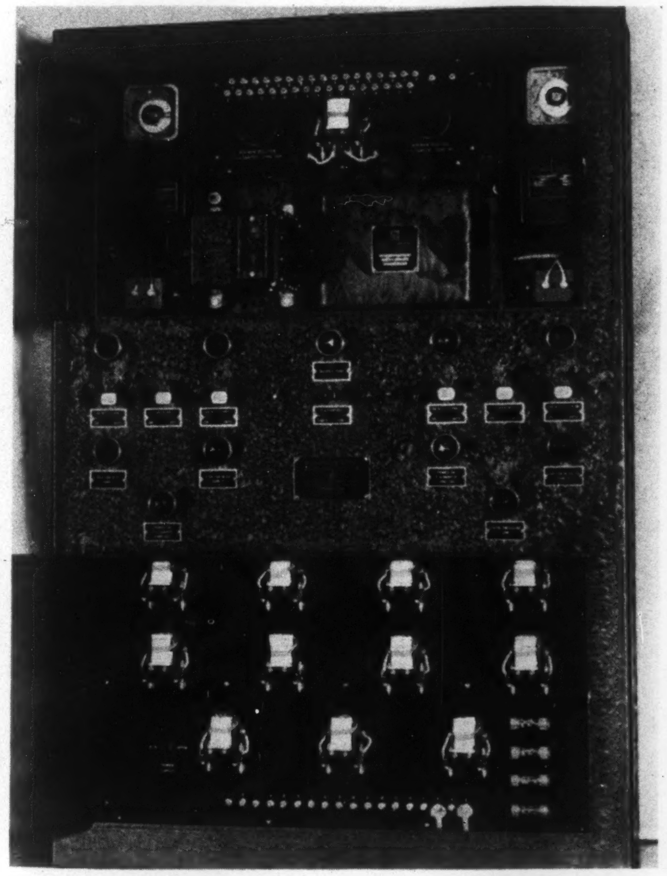
The location of the building necessary to comply with the zone accessibility requirements of the school district is on undesirable soil only a few hundred feet from a creek, so that precautions against settling walls and water seepage were necessary. The ground elevation was therefore raised approximately 6 ft and foundation stability was acquired by the use of about 650 concrete piles. Because of the possible water seepage only a partial basement was constructed to accommodate the heating and ventilating equipment.

The construction of the boiler room and equipment spaces involved a water tight pressure slab below the final floor level, so that the spaces are in reality surrounded by a single water tight wall and floor structure. Further protection against water damage is afforded by a duplex pump system.

### Coal Handling

The coal bin is on the north wall of the boiler room and the chimney on the south. The coal is fed automatically from the bin to the boilers; the only manual operation required is the removal of clinkers.

The bin holds slightly more than two carloads of coal. One carload takes the place of sloping sides in the bin to facilitate the flow of coal toward the conveyor screw and serves as reserve storage should there be delays in coal delivery during cold weather. The structure of the build-



**Central control panel for the entire control system, illustrating the trend toward coördination of the functions of all of the mechanical equipment in a building from one point and minimizing the attention required of the operating engineer, according to the author. All of the fan starters, relays, stoker controls, etc., are regulated through this panel. Red and green lights indicate the operation of the various phases of the system. Inside the panel are clocks that automatically start and stop equipment so that no attention to the system is required of the operating engineer unless certain zones are to be operated at night, at which time he turns the switch on the front of the panel placing the particular zone under daytime schedule. As soon as the switch is turned off the zone is again clock controlled**

ing did not lend itself to the erection of a coal bin with sides sloping to the bottom which would be large enough to meet the requirements.

Coal is delivered from the coal bin to an elevator pit by means of a floating screw feed. From this pit the coal is elevated and discharged through chutes leading to the stoker hoppers from the top of the elevator. This arrangement provides sufficient additional coal storage so that in the event the conveyor fails during the night period enough coal is available to keep the stokers in operation until morning.

The coal conveyor assembly is automatically controlled, coal being delivered when a minimum level has been reached and the conveyor being shut down when the coal is up to a predetermined point.

### The Stokers

The stokers have long screw feeds to the boilers so that there is sufficient room between the stokers and the boilers for cleaning the flues, attending the fires, etc. The stokers each have a capacity of slightly more than 500 lb per hr and are automatically controlled from the standpoint of air quantity and firing rate.

The stokers are connected through a combination relay and alarm system in such a way that when a pin is sheared the circuit to the shear pin assembly is broken, causing the relay to the stoker motor to drop out, shutting down the stoker to avoid blasting the fire with air when no coal is being fed. When the relay falls out contact is made to an electric bell alarm which rings until the stoker is serviced.

All of the equipment in the boiler room, such as the feed from the stoker to the boilers and from the coal bin to the elevator, is below the floor level so that the entire boiler room floor is free from any obstructions. All of the coal handling equipment is commercially dust tight to promote cleanliness.

Emergency openings to the storage bin and to the elevator pit are provided so that coal can be manually shovelled into the pit in the event of failure of the screw feed. Access to either stoker is provided so that if the elevator should fail to function properly coal can be manually shovelled into either hopper. The screws and all mechanical parts of the equipment in the boiler room are readily accessible and can be removed with little difficulty.

### Two Steel Boilers

Two steel boilers, each having a capacity of approximately 15,000 sq ft EDR, provide the steam generating equipment for the building. The boilers are equipped with automatic water feeders and low water cut-offs, and are automatically controlled from the central control panel, as are the stokers. Either boiler or both can be placed in operation from the control panel. A constant steam pressure is maintained during daytime operation or when any zone in the building is in use. During the night or weekend period the boilers are on hold fire control and provide steam pressure only in the event that one of the zones in the building calls for heat by reason of its average temperature falling below the predetermined minimum setting (approximately 55 F).

A duplex vacuum and condensation pump returns the condensate. The control of the duplex assembly is arranged in such a way that the two pumps alternate in their operation. Should either pump fail, the other automatically operates to take care of the load. Also, if the water should come back at a rate greater than the capacity of one pump, so that the water level in the receiver rises above a certain point—which situation theoretically should never occur—, both pumps are automatically started.

The ash conveyor is a special litter carrier adapted for this purpose. A track runs along the ceiling of the boiler room from which is suspended a moving trolley supporting a hopper having a capacity of about 12 bushels. This hopper can be lowered to the floor level, a distance of about 18 ft, to receive the clinkers from the boilers. Normally it is left in the lowered position until filled, at which time it is raised to the upper level and carried along the track out of a door in the side of the boiler room. As the boiler room floor is approximately 12 ft below ground, this arrangement serves both to elevate the ashes and to convey them from the boiler room proper to the ash pile or truck.

A separate horizontal type hot water boiler for burning refuse also provides a source of heat for the hot water supply during the time of the year the heating boilers are not in use. When the heating boilers are in operation hot water for the building is maintained at a constant temperature by means of automatic regulation of steam to a heating coil in the hot water storage tank. This heating coil is readily removable from the storage tank for inspection and repair.

On the wall between the boiler room and the equipment spaces is the air compressor for supplying air to the pneumatic part of the control system and the master control panel which automatically regulates all of the mechanical equipment in the building.

### Heating and Ventilating System

The heating and ventilating system is essentially a central plant consisting of four zones, each having booster coils in the branch ducts to each classroom for the control of temperature. The four zones (the north, east, south and west sides of the building) are independently controlled so as to compensate for sun effect, etc. The east zone is supplied with approximately 15,000 cfm of air, the west zone with 12,500, the south zone with 7500 and the north zone with 4000. The duct distribution system required slightly more than 60,000 lb of sheet metal, this portion of the heating and ventilating contract amounting to about $10,000.

The heating and the ventilating are accomplished by the same system, the air leaving the central station at a temperature of from 60 to 70 F depending upon the zone requirements, and being heated to a maximum final temperature of 135 F by the booster coils in the ducts to each room. Thirty cubic feet of air per occupant is circulated throughout the building, a minimum of 12 cfm of air being introduced from outdoors whenever the building is occupied.

An outdoor air duct extends from the equipment space below ground to the roof of the building. In the equipment space the outdoor air duct combines with the recirculating duct from each zone of the building, and a common duct then extends to the central ventilation station.

There the air passes through a double bank of adhesive type filters to a preheater section, consisting of "tube-within-a-tube" type extended surface heaters. From the preheater the air enters the air washer, and is discharged from there into the fan room, which serves as a plenum for the incoming air.

In the fan room are backward curve type fans with variable inlet vanes for each zone. The fans and motors are set on soundproof bases and are connected to the main supply ducts extending beneath the center of the building to the various zones.

The air leaving the fan for each zone passes through a reheater coil with face and bypass dampers and through a set of fire and air dampers. Each main duct in the building is equipped with an automatic fire damper and with an air damper that closes whenever the zone fan is not in operation so that the air is not pulled back through the inlet of the zone fan.

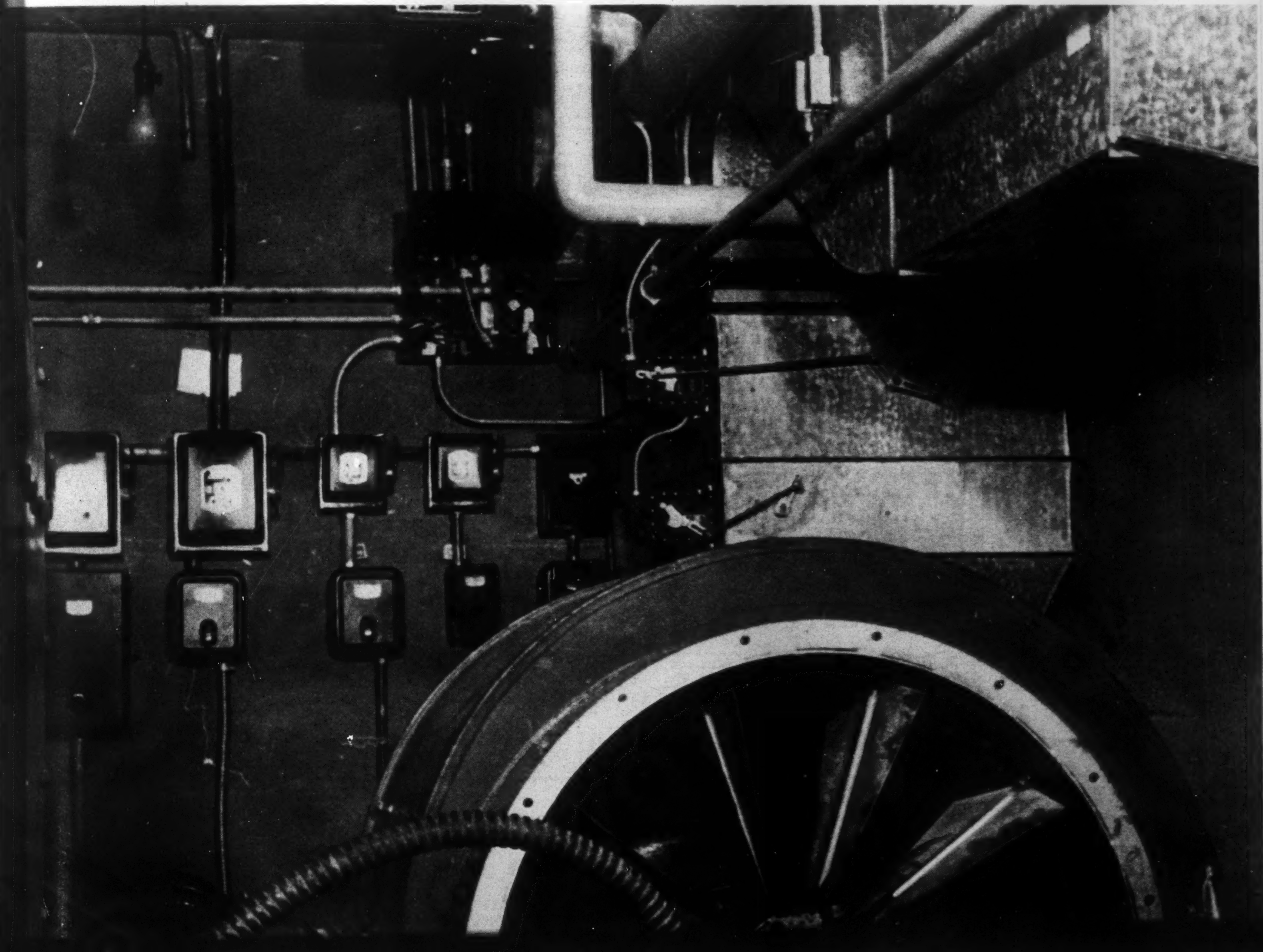
In addition there is installed at the water tight wall between the equipment spaces and the general space beneath the building dampers to prevent flow of water into the equipment spaces should water rise high enough to reach the duct work. These dampers are arranged for either manual or automatic operation, and are so devised that when connected to an electric damper motor they are held open when the system is in operation. When the water rises a float switch breaks a circuit to the damper motor, causing them to swing closed. The dampers are heavy steel construction and are held closed by the pressure of water against them. Also, on the equipment space side of the dampers are several catches that are fastened manually when the flood condition seems to be serious, thereby insuring a minimum of leakage around the edges of the dampers, which fit against resilient material forming a gasket.

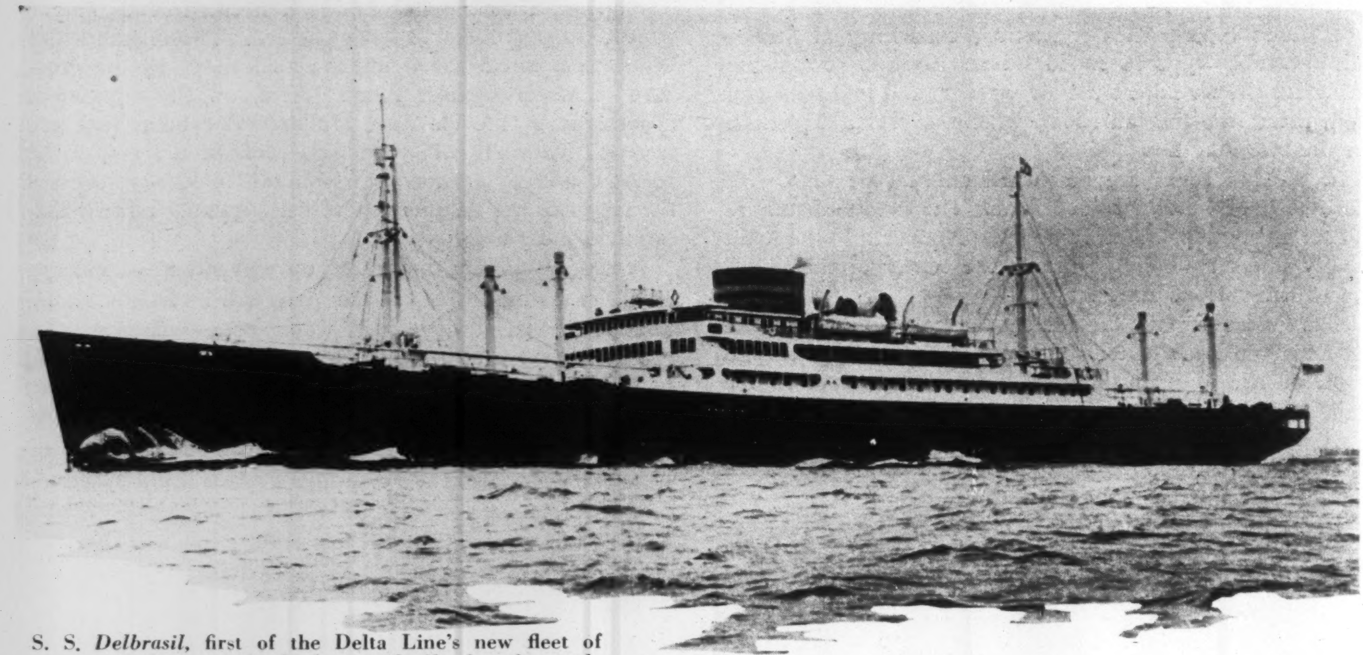
It is not expected that the water will often rise so high, and it is assumed that the dampers will be locked manually. This year during high water none was present in the space. Should it occur there will be a certain amount of leakage into the equipment spaces, and to take care of such water a duplex pump system has been installed to handle a large quantity of water from a sump which collects the water from the equipment space drain system.

The architect for this school was M. B. Cleveland, Wheatland Co. was the heating contractor, and the sheet metal work was done by A. J. Schultz & Sons. The author was the consulting engineer.

[*Mr. Todd's next article will cover the method of air distribution, which is somewhat unusual and in which considerable interest has been shown, and will explain in detail the automatic control system and its operation.*]

**Some of the controls and switches which are automatically regulated through the central control panel**





S. S. *Delbrasil*, first of the Delta Line's new fleet of passenger-cargo vessels, built specifically for the trade between New Orleans and the east coast of South America

# Heating, Ventilating and Air Conditioning on Shipboard

## John H. Clarke* of United States Maritime Commission Explains Details of Installations for Marine Service

### SUMMARY

**Great strides are being made today in the application of heating, ventilating and air conditioning to our merchant ships. Old rule-of-thumb methods are rapidly passing and naval architects and marine engineers are aware of the importance of good design, equipment and insulation and proper adaptation of the various systems. Probably one of the most outstanding features of the Maritime Commission's present program is the emphasis placed upon proper ventilation, refrigeration and humidity control for cargo holds . . . An article in the August HPAC was devoted to the Maritime Commission's program, problems peculiar to marine work and types of systems used on shipboard; in September, control was considered in detail, together with machinery space and cargo hold ventilation. This month, information on duct design and construction, fans and motors, heating and cooling surface, air filters, humidification, insulation, refrigeration and piping for service on shipboard is given**

In air conditioned (or air cooled) spaces on shipboard, outside air is supplied on the basis of 30, 40 or 50 cfm per person for staterooms (depending on size). This outside air represents a maximum of about 25 per cent of the total air through the stateroom coolers for summer operation, the balance being recirculated air. In winter, when these same units are used for heating, the amount of recirculated air would be considerably less. In dining saloons and similar spaces outside air requirements are based upon about 15 cfm per seat or else air is circulated at about a four minute rate with about one-fourth of this amount being outside air. In these spaces the capacity of the equipment is generally sufficient to maintain a 10 or 15 F drop in the ambient temperature, and under normal conditions, to maintain a relative humidity of between 50 and 65 per cent. In spaces other than those that are air conditioned, ventilation is based on an air change rate of about six minutes for staterooms, and about eight to 10 for public rooms. Working spaces are furnished with supply or exhaust or both in proportion to their needs for removing heat or odors. In some few spaces—like the gyro room or the machinery spaces—ventilation may be based on a maximum allowable temperature rise of 15 F (or more, depending upon the nature of the space) over ambient for summer conditions.

### Details of Duct Construction

The ventilation ducts are generally rectangular in cross-section. Whenever possible, bulkheads and decks are used as the sides of the ducts. All ducts are designed according to good commercial practice with guide vanes being fitted wherever less than a one-half standard throat radius must be used. Dampers are provided at all main branches, and manually or automatically operated waterproof or fireproof dampers must be installed whenever a waterproof or fire screen bulkhead is pierced.

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*Technical Div., United States Maritime Commission.

The duct thicknesses now specified in marine work are as follows: Vertical and horizontal ducts 24 in. and over, No. 16 ga; over 12 in. to 24 in., No. 18; above 6 in. to 12 in. inclusive, No. 20; 6 in. and under, No. 22. (The dimensions given are either the diameter of a circular duct or the longest side of a rectangular duct.) These dimensions are general and must be revised to suit specific cases. For instance, in the cargo holds it is necessary to increase the above thicknesses to $\frac{1}{8}$ or $\frac{3}{16}$ in. and to strengthen the hangers accordingly in order to avoid damage from cargo handling. This is one of the reasons why kingposts are used extensively for hold ventilation.

Balancing of the duct systems is done mainly by sizing, and estimating the duct friction of the various branches by means of standard methods as described in the ASHVE Guide and other texts. Balancing dampers are provided where necessary. The use of orifice plates is being discouraged and they are definitely excluded by all new specifications.

Duct velocities for living spaces are limited to 2000 fpm in mains and 1500 fpm in branches. In the refrigerated spaces where the circulating rate is very high the velocities are kept below 2000 fpm to avoid excessive power requirements. For the same reason velocities are kept below 1500 fpm in the cargo spaces in which the humidity control systems are installed.

In order to assure quiet operation, terminals of the "high velocity" type are now being used in the living spaces. All terminals in living spaces are equipped with dampers. In some living spaces universal terminals have been supplied. These terminals are nothing more than cones fitted at the end of a circular branch duct. Two or three "V" sections of the duct preceding the cone are joined by working joints so that the outlet can be pointed in a variety of directions. The same outlets are usually used in the machinery spaces and other working spaces where it may be advantageous to be able to vary the direction of "throw." Dampers are generally furnished. Direct duct and scoop outlets (outlets in the side of a duct with a deflecting plate in the duct) are furnished in machinery, cargo and working spaces. All supply outlets, exhaust inlets and other openings in the ventilation system must be covered with wire mesh or grille work of ½ in. or under clear openings. This is done not only to ratproof the system, but also to prevent the concealment of stolen or smuggled goods and to prevent plugging up the ducts with anything that might otherwise get into them. Outlet velocities in living quarters vary from 1200 to 1800 fpm for the "high velocity" terminals and from 500 to 1000 fpm for ordinary terminals. Around 500 fpm is better design even though the higher velocities are used. In working spaces where the noise level is high, the outlet velocities range from 1000 to 2000 fpm.

## Types of Fans Used

Ventilation fans for most of the systems and particularly for ventilation in the living spaces are of the centrifugal type. Fans of the backward curved vane, limit

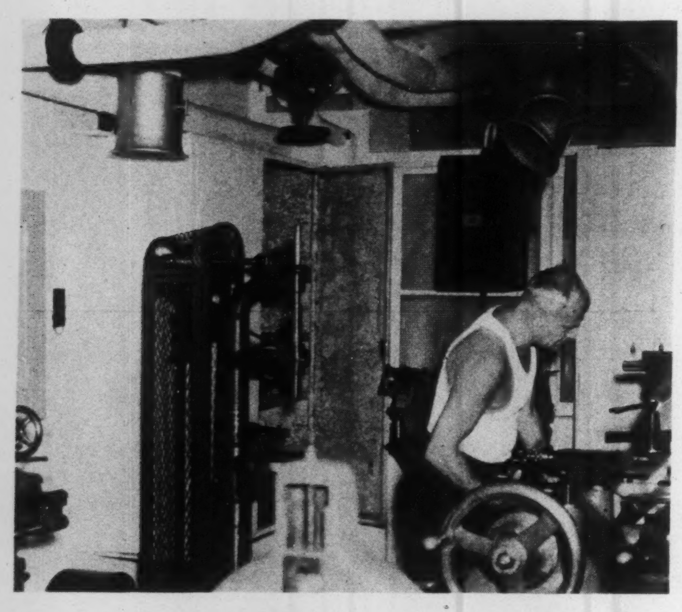
**A boiler room view of the United States Lines' new luxury liner *America*. One of the most unusual mechanical features of the ship is the arrangement of separated boiler rooms with the engine room between, a design which presents minimum interference with passengers' quarters and has the advantage that in case of flooding of one set of boilers, the turbines can still be operated from the second boiler room. All three machinery spaces are protected from collision damage by fuel oil tanks**

load design, or of the slow speed forward curved vane design, are used. Fan outlet velocities are limited to about 2000 fpm with maximum wheel tip speeds of 10,000 fpm. Static pressures run about 2 or 2½ in. for supply systems and 1 in. for exhaust systems except in the machinery spaces and cargo holds where, because of the short straight runs, the static pressures seldom run above 1 or 1½ in. Fan capacities are confined to 5000 to 8000 cfm for systems in living spaces and for centrifugal fans.

The maximum capacities for centrifugal fans for marine use in this country are generally about 12,000 or 15,000 cfm, these fans being used for ventilating the machinery spaces. Larger centrifugal fans—as high as 50,000 cfm—have been used for the machinery spaces on such ships as the *America*. Propeller or axial flow fans have been used extensively for the machinery and cargo spaces on these modern ships and for American ships have had capacities of 24,000 cfm against a static pressure of about 1 in. These static pressures must be kept down to keep noise at a reasonable level. Propeller fans have been used at low capacities (1000 to 3000 cfm) for hold ventilation. In these instances the fans are often placed in kingposts or other ventilating cowls or intakes.

All fans are direct connected on the same shaft as the driving motor and in the case of the centrifugal fans, are usually of the single inlet overhung type. In order to minimize the transfer of sound and vibration, felts, rubber foundation inserts or vibration dampeners are often resorted to. For the same reason the connecting sleeves of the ducts to the fans are made either of canvas or rubber.

The fan motors where direct current is used are of the 230 volt shunt wound, drip proof type. In the few cases where alternating current is provided 440 volt, 3 phase, 60 cycle drip proof motors with squirrel cage windings and synchronous speeds of 1200 or 1800 rpm are used. Speed reduction is generally supplied in the order of 25 or 33 per cent and in some special cases, 50 per cent.



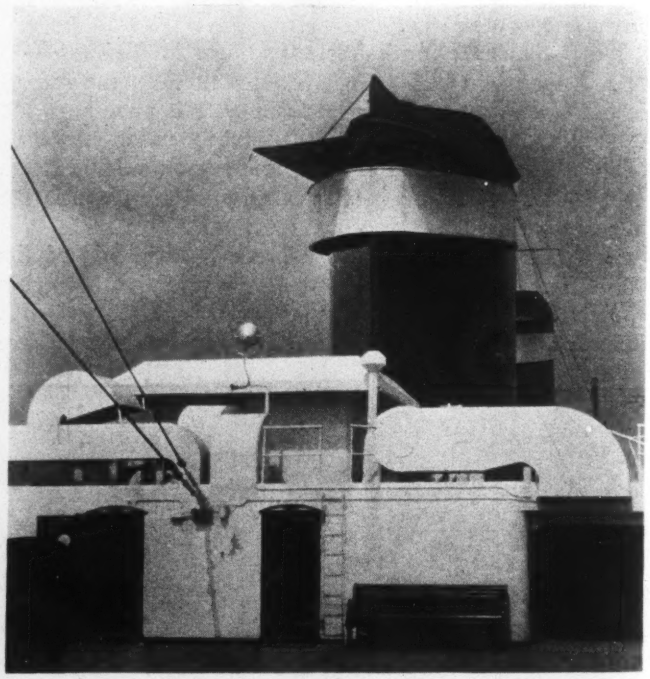
**Workshop on the *America* showing terminal and directional duct outlets. Note the screening over the ends of the ducts**

### Heating and Cooling Surface

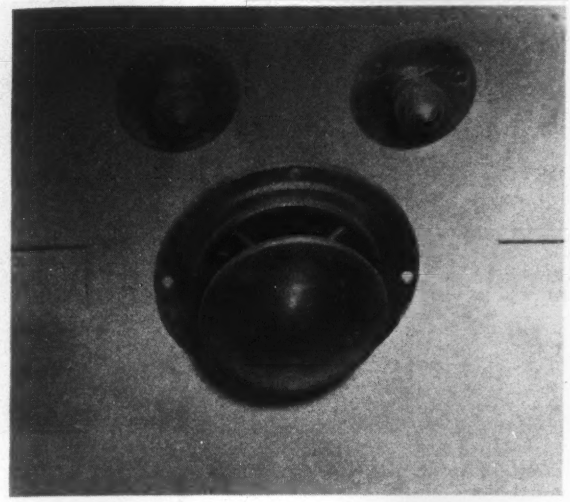
All air heating and cooling equipment such as radiators, unit heaters, air heaters and air coolers is now required to be constructed with copper finned tubing, with some few exceptions for radiators. For steam equipment the use of the header type of construction is being encouraged because of its better operation, better drainage and quieter operation. This is particularly important for air heaters which are exposed to freezing temperatures, since the rolling of the ship may cause freezing at the bends if the return bend type of heater is used. As an added protection and in order to obtain better control arrangements, the non-freezing type of air heater (excepting reheaters) is being specified. Face velocities for air heaters are limited to from 600 to 700 fpm with a maximum friction drop of 0.25 in. of water.

### Air Filters

Air filters of the washable type are now being specified for all supply systems. In many ventilation installations the fan rooms are provided with louvers in the deckhouse sides and there is no duct connection between these intakes and the air heater or supply fan inlets. In such instances it has been customary to place the filters directly inside the louvers. In such a location the filters may become clogged with snow and sleet, and such an arrangement permits dust and dirt in the fan room to get on the heaters and clog them up. More important, it allows dirt and dust to travel through the system. To avoid these difficulties it is better to place



**Upper deck of *America* (sun deck) showing some ventilation duct intakes and the "jockey caps" on the stacks. These deflectors were placed on the stacks so as to create an upward current of air which would keep soot and flue gases off the decks and out of the ventilation systems. The trials of the ship showed that it was necessary to raise the height of the stacks to accomplish the desired results, so they were increased in height before delivery of the ship. Incidentally, the forward stack is a dummy so that the aft stack is the critical one**



Dual duct outlet for the ventilation heating system of the cabin class staterooms on the *America*. The outlet deflector is cone shaped so as to diffuse the supply. The two controls shown are attached to the duct dampers in the hot and cool ducts terminating at the outlet

the filters at the inlets to the duct systems ahead of the air heaters or fans.

### Humidification

Humidifiers have been installed in a number of ships but as yet this feature has not had a wide marine application. Opinions vary as to the desirability of humidifying on shipboard but it is something that certainly should be given serious attention on routes where high temperature air will be needed for heating. So far both steam and water sprays have been furnished. Where it is possible to get a good source of odorless steam—as is usually possible in marine work—it would seem that this would be best since it evaporates more readily and consequently will mix better and will not be conducive to carry-over. One very interesting arrangement for humidifying consists of a 1 in. pipe with a single row of perforations along the bottom. The pipe extends across the intake duct following the preheater. Under the pipe is a half oval deflecting plate to break up the jets of steam and deflect them into the air stream. The quantity of steam is controlled by a stop valve and an orifice.

### Insulation Used More Extensively

Insulation is now used more extensively on cargo and passenger ships alike, with the result that heat transfer has been materially reduced. It was necessary for this to be done, of course, before air conditioning could become more widely used. Today on exposed surfaces 1 in. or more of insulation is being applied in the living spaces, all beams and bulkhead stiffeners being covered with fireproof sheathing to cut down the heat transfer and at the same time make a more pleasing appearance. The only exception to this is in the toilet and shower spaces where cork paint only is supplied. This means that the overall heat transfer rate for living spaces has been reduced from 1.25 for painted plating, 1.00 for cork paint or 0.45 for 1 in. of insulation (beams and stiffeners uncovered), to transfer rates of 0.20 to 0.35 for modern spaces using both insulation and sheathing for the beams and stiffeners. This reduction represents quite a saving.

### Steam and Refrigeration Piping

For all steam heating by ventilation air or radiators the capacities are based on 0 to 10 F outside air temperatures. The steam pressures used are generally 30 to 35 lb ga. Pressures of 20 lb have been used occasionally and some air heaters have operated on 5 lb steam. Many of the diesel ships operate their heating systems on 50 lb steam due to the fact that they use combined waste heat and oil fired boilers for steam, and these boilers operate at 50 lb pressure. In a few instances on the diesel ships, engine room radiators are operating with 100 lb steam or the full boiler pressure for these ships, but the rest of the heating system operates at reduced pressure. The above steam pressures are those obtained either at the reducing valve or at the boiler for systems using full boiler pressure (diesel ships). This steam at reduced pressure generally contains about 50 to 100 F of superheat for steamships.

The pressure drop in the steam lines is about 5 to 10 lb depending on the length of run. Supply lines are sized on the basis of allowable velocity for each size of pipe. All steam drains have a back pressure of 5, 10, 15 or 20 lb depending not only upon the length of run but also on whether or not the condensate drains to an atmospheric tank or to a part of the condensate system which may be under a pressure of about 10 lb ga. Drain piping is usually figured on the basis of the pipes flowing full at a velocity of 18 or 20 fpm.

Piping for steam systems is seamless or lap welded steel with cast steel or malleable iron fittings. Each steam unit is furnished with a stop valve on the supply and a thermostatic, bucket or impulse trap, and cut-out valve, on the drain. While thermostatic control valves have not always been required for air heaters they are

## MERCHANT MARINE VITAL ELEMENT IN DEFENSE

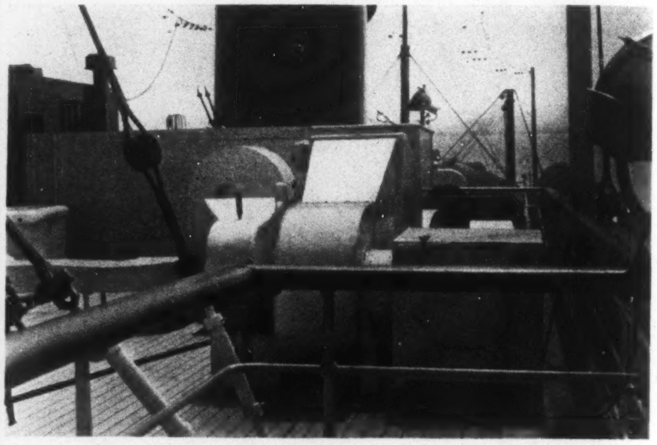
**A nation's merchant marine is a vital element in its national defense plan, for transportation of essential materials from sources of supply throughout the world must be assured and the fighting navy requires auxiliary ships of numerous types. Some of the ships to be built under the Maritime Commission program are understood to be designed for conversion to aircraft carriers in time of war. . . . While the Commission's program was initiated in 1936 when Congress passed the Merchant Marine Act, it has become of greatly increased importance within recent months because of the emphasis on national defense and re-armament. The purpose of the program is to provide about 500 new ships over a period of 10 years to replace our ever-growing number of over-age ships, and at the same time to bring about a practical coördination of replacement and retirement in order to stabilize the shipbuilding industry of the U. S. It can be seen that the latter phase of the program is also a most important contribution to U. S. defense, for in modern warfare—as never before—the industries of a nation are an essential line of its defense.**

**—The Editor.**

being specified now due to the fact that it is felt that ventilation systems cannot operate satisfactorily with manual operation. On ships like the *America* where there are 50 ventilation supply systems, manual control is obviously impractical. In addition strainers are specified to protect all control valves and thermostatic traps for the air heaters. In some cases bypasses have been furnished around control valves and thermostatic traps although this is not now required, since these items usually fail in the open position and since stop valves are fitted on the supply and return. Further, such equipment as air heaters can be shut down if necessary for a short time without undue inconvenience while repairs are made.

The air conditioning equipment is supplied with refrigeration by either multi-stage centrifugal, or by vertical or V-type truncated piston reciprocating compressors. The condensers are of the shell and tube type using sea water as a cooling agent. The condensed "Freon-12" is led to a receiver and thence distributed to brine coolers or to direct expansion coils for the various units. Wherever possible, and when reciprocating compressors are used, the air conditioning compressors are made duplicates of the cargo refrigeration compressors and are run at a speed to suit the load. This results in a material saving in spare compressors as well as spare parts.

The control equipment for air conditioning coils and coolers generally consists of solenoid and automatic thermal expansion valves for refrigerant control, and temperature regulating valves for controlling the chilled water circulating rate. Damper and other controls were briefly discussed previously. While brine coils have been used extensively, practically all installations on the ships now building are either for direct expansion of "Freon-12" or for chilled water. Chilled water is used for stateroom coolers but the large units for dining saloons may use either chilled water, brine or direct expansion of "Freon-12."



**Group of ventilation intakes, fans and air heaters on the sports deck of the *America*. The heaters on the right are for a dual duct system, the duct being split at the fan outlet; one duct leads to a heater for the hot duct, and the other to the tempering heater for the cool duct**

Where chilled water is used some sort of anti-freeze solution is generally added to prevent freezing under extreme conditions of operation. For passenger ships the rules forbid the use of ammonia as a refrigerant, and while this rule does not apply to cargo ships, the Maritime Commission has so far discouraged its use.

Refrigerant and brine piping is copper with composition fittings. These specifications, however, do not include the piping for refrigeration wall pipe coils in cargo and ship's service spaces.

[*This is the third of three articles on heating, ventilating and air conditioning on shipboard.*]

## Round Numbers—

[*Concluded from p.* 606]

standard for very large pipe followed this plan. Yet analysis shows that in the general case maximum economy requires *equal ratios between successive sizes.* This means that the series shall be a geometrical one and thus have equal percentage increases between sizes.

As an illustration, suppose it has been decided that five sizes of general purpose motors are needed to bridge the span from 10 to 100 hp. It can be shown mathematically that the greatest over-all economy in the use of material and labor will be obtained if the motors increase in power by a constant ratio between successive sizes. The sizes then become 10, 16, 25, 40, 63, 100 hp respectively. This is a 60 per cent increase from size to size. In the 5-Series of Preferred Numbers the steps are approximately 60 per cent; in the 10-Series, 25 per cent; in the 20-Series, 12 per cent; and in the 40-Series, 6 per cent. Larger or smaller sizes are obtained by merely shifting the decimal point.

Everyone is familiar with the process of "rounding off" decimals so as not to be bothered by carrying unnecessary figures that are not justified by the accuracy of the data. Most people, however, are not familiar with the fact that the method usually taught in the public schools is erroneous in one imporant particular. Rules for Rounding Off Numerical Values have just been issued by the American Standards Association. The most interesting feature of the new standard is that the correct method of rounding is emphasized in it. The particular point is how the rounding is to be done when the excess figure is a 5. The method generally taught in the schools is to round to the next highest figure in all cases. This is obviously wrong since on the average it will lead to cumulative errors.

The correct method, which is used in statistical work and in precise scientific calculations, is to round to the even figure; *e.g.* 3.25 is rounded to 3.2; 0.215 is rounded to 0.22; 6.75 to 6.8. The new standard sets forth this method and the reasons for it with meticulous care.

A simple illustration will make clear how the unscientific method of simply taking the next higher figure leads to cumulative errors. Let us divide the odd numbers from 1 to 13 by 2, then round the quotients by each of the two methods, add, and multiply by 2. The problem is

$$(0.5 + 1.5 + 2.5 + 3.5 + 4.5 + 5.5 + 6.5) \times 2 = 49$$

By the incorrect method (taking the next higher figure) we have

$$(1 + 2 + 3 + 4 + 5 + 6 + 7) \times 2 = 56$$

By the correct method (rounding to the even figure) we have

$$(0 + 2 + 2 + 4 + 4 + 6 + 6) \times 2 = 48$$

The error in rounding by the correct method is but 1; while by the incorrect method it is 7.

## *HEATING, PIPING AND AIR CONDITIONING DATA SHEET*

# Cost of Steam With Oil as Fuel

## Chart Prepared by Irving E. Brooke, Consulting Engineer, Gives Complete Data for Easily Computing the Cost of Fuel

SUMMARY

**For use in his consulting work, Mr. Brooke has prepared charts for determining the cost of generating 1000 lb of steam using coal, oil or gas as the fuel. Whether the basis of comparison is 1000 lb of steam generated, a certain number of gallons of water heated, or some other basis, the relative cost will not change . . . Feature of the charts is that complete data are given, but that they are still easy to use. The one for oil is reproduced on the next page, the chart for coal appeared last month, and those for gas will be published next month . . . To use the chart, enter it at the bottom on the scale for thousands of Btu per gal of oil and go vertically until either the per cent efficiency (diagonal lines), evaporation in lb of water per gal of oil (left hand scale), or gal of oil per boiler hp-hr (right hand scale) is intersected. From this point go horizontally either to right or left until the curve for cost of oil in cents per gal is intersected. From this point go vertically to the scale at the top of the chart and read the cost of steam in cents per 1000 lb . . . These charts are of particular value to industrial plant engineers and others who are giving thought to possible changes in availability or cost of the various fuels due to the national defense program**

MANY articles have been written on the comparative cost of various fuels, and many charts, diagrams and tables have been published. It is unfortunate that many such data have been designed to show certain results—namely, that some one certain fuel was cheaper than some other fuel. The lowest price of one particular fuel would be compared with the highest price of another fuel in a given territory, or a comparison would be given between fuels, one of which would not be at all suitable for use under the conditions assumed. It should be borne in mind that the first cost of fuel is only one of the factors involved.

All of these conflicting data leave the fuel user in a somewhat confused state of mind—a state often intensified by the over-enthusiastic salesman for any particular fuel or equipment who cites numerous instances where his fuel or fuel using equipment has replaced another fuel or equipment, and the user has saved any amount up to 50 per cent of his previous fuel cost.

Recently I prepared some charts on the comparative cost of fuels. The desire to make such charts was prompted by the fact that those available either did not cover a sufficiently wide range of fuel costs or were too much involved; that is, they gave too much information on the same chart for ready and accurate comparison, so that you were following a line until you were "lost in the woods."

After many preliminary trials, it was decided to make one chart for each fuel and to arrive at a fuel cost of 1000 lb of steam as the basis of comparison. Whether the basis of comparison is 1000 lb of steam produced, gal of water heated, or cu ft of air heated, the relative cost will not change.

My chart for oil appears on the next page; the one for coal was published last month, and the one for gas—as well as a chart for quickly comparing gas costs either on the basis of the cost per therm or per 1000 cu ft of gas of various Btu values—will be presented in the November HPAC.

### Use of the Chart

A feature of the chart is that it can be used if either the per cent efficiency, evaporation in lb of water per gal of oil, or gal of oil per boiler hp-hr is known. Starting at the bottom of the sheet, select the value of thousands of Btu per gal of oil and go vertically until the line intersects either the per cent efficiency (diagonal lines), evaporation in lb of water per gal of oil from and at 212 F (left hand scale), or gal of oil per boiler hp-hr (right hand scale). From this point, go horizontally either to the right or left until you intersect the curve indicating the cost of oil in cents per gal. From this intersection, go vertically to the top of the sheet and read the cost of steam in cents per 1000 lb.

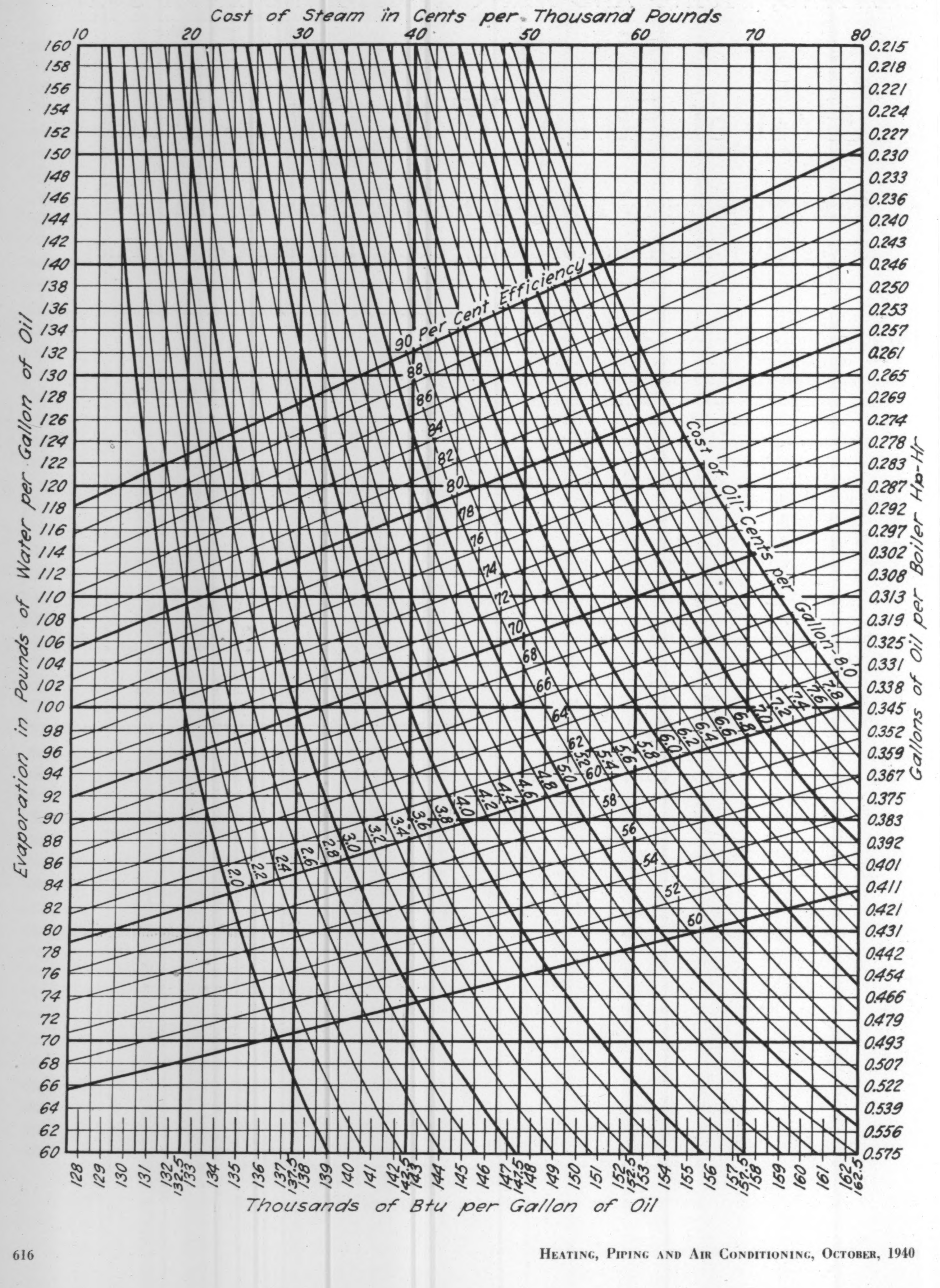
If the price of oil does not fall within the range of the chart, the method may still be used. For instance, if the cost of oil were 10c, the 5c curve would be used, multiplying the steam cost read from the chart by two.

### Example of Use of Chart

Assume the heat value of the fuel to be 140,000 Btu per gal, efficiency 64 per cent, and cost 4c per gal. Enter the chart at the bottom scale at 140, and go vertically to the 64 per cent efficiency line. From this intersection go horizontally to the right until the 4c curve is crossed. From this second intersection, go vertically to the top of the chart and read on the top scale the cost of steam to be 43c per 1000 lb.

# Cost of Steam Using Oil as Fuel

*[See instructions for use on preceding page]*



# AMERICAN SOCIETY of HEATING and VENTILATING ENGINEERS

# Journal Section

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October with its clear, cool days brings Chapter members together for the Fall Season of monthly meetings—31 ASHVE chapters are now rendering service in their communities . . . . . . . October 6-12 is Fire Prevention Week to remind us about the necessity for safety, safeguards for appliances, as well as adequate inspection and proper operation of all mechanical equipment used for heating, ventilating and air conditioning service . . . . . . Cotton Country's Calling—October 14-15 for the Society's Fall Meeting at Houston and some interesting papers for the Meeting are published in this issue . . . . . . Coming Meetings scheduled by the Society in 1941—47th Annual Meeting, Kansas City, January 27-29. Semi-Annual Meeting, San Francisco, June 16-19.

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22. *Flow of Fluids Through Pipes and Fittings:* S. R. Lewis, *Chairman;* L. A. Cherry, G. C. Davis, T. M. Dugan, Earle W. Gray, R. T. Kern, H. A. Lockhart, Axel Marin*, R. F. Taylor, E. L. Weber.

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*Member of Committee on Research.

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# Direct Evaporative Cooling for Homes in the Southwest

By A. J. Rummel,* (*MEMBER*), San Antonio, Texas

## SUMMARY

**The application of direct evaporative cooling equipment in residences has had a mushroom growth in the southwest and the author gives an analysis of climatic conditions and presents a comfort chart which covers conditions that prevail in the southwest. A test house installation is described and the results of numerous investigations of varying conditions of air supply and air change are summarized. The investigation indicates that the conditions reported are at the upper limit of comfort conditions and any higher indoor effective temperature would not be acceptable to the average home owner. It is recommended that further studies be made in other localities so that ultimately standards for this type of cooling equipment can be prepared**

IN certain sections of the Southwest it has been observed that during the past several years greater public interest in the installation of direct evaporative cooling equipment in residences has occurred. In fact, in the areas where this type of comfort cooling is effective, the number of installations has outnumbered all other types of installations by a 10 to 1 ratio.

The mushroom growth of these installations and the increasing public desire for definite information as to just where and how effective and successful these installations are in those sections where the results might be considered doubtful, or on the borderline, resulted in the study reported here.

The history and theory of the natural phenomenon of evaporative cooling is well known, and the study made and reported, was not to determine the merits of the different type units available, or the effect of the shape of pads or blades, dimensions of units, method of water distribution, etc., but only an investigation of the best results that might be expected when the system was installed and operated under conditions considered to be the most effective.

Since there are no generally accepted or definitely established standards for the cooling of residences by simple evaporation, the first step in such an investigation and study was to analyze the climatic conditions existing in different parts of the country, and to analyze the results of research as to temperature, humidity, air motion, etc., as related to human comfort.

An analysis of the climatic conditions of the United States for the past 10 years indicates that there is a strip of approximately 400,000 square miles, about one-eighth of the total area of the United States, extending across parts of Texas, Oklahoma, New Mexico, southern Arizona, Nevada and California, in which the temperature and humidity conditions are such as to make the use of direct evaporative cooling practical. Although in most sections of this strip the use of direct evaporative cooling is effective in varying degrees, there are also sections where the relative humidity would permit the use of these systems but the maximum temperatures do not justify their use.

As previously stated, the effectiveness of these installations varies according to the location. For instance, in the territory of Phoenix, Ariz., the record of summer daytime wet- and dry-bulb temperature readings indicates that these units might be expected to be effective 85 per cent of the time during the summer months. In Yuma and Tucson, Ariz., they might be expected to be effective 70 per cent to 75 per cent of the time; in El Paso, Texas, 65 per cent; Oklahoma City, 60 per cent; San Antonio, Texas, 50 per cent, to practically zero per cent as the coast line is approached. The foregoing is on the basis that evaporative cooling is not effective in territories where the wet-bulb temperature exceeds 75 F for more than 5 per cent of the time during the summer.

Recent investigations[1] by the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS indicate that the optimum effective temperature for completely air conditioned buildings in the Southwest, in which the period of time spent by the occupants is two or three hours, is approximately 73 F. Similar studies[2] conducted in the northern and eastern parts of the United States indicate that the optimum condition in those sections of the country was approximately 71 deg ET. These investigations tend to indicate that individuals in the area where evaporative cooling might be considered effective would be comfortable in conditions approximately 2 deg higher in effective temperature than is commonly thought of as the optimum comfort condition based on the present day published comfort charts.

The question of maintaining comfortable conditions with high relative humidities, as is necessary with direct evaporative cooling, almost always invites some criticism. However, recent studies in this connection seem to indicate very little difference in comfort with humidities at the upper limits of the comfort chart. The 1940 edition of the HEATING, VENTILATING AND AIR CONDITIONING GUIDE has the following to say regarding the limits for comfortable living conditions:

> Preliminary experiments at the ASHVE Research Laboratory would seem to indicate no appreciable impairment of comfort with relative humidities as high as 80 per cent provided the effective temperature is between 70 and 75 deg.
>
> ......74.5 deg ET and lower, results in satisfactory comfort conditions in the living quarters of a residence and while this condition is not representative of optimum comfort it provides for sufficient relief in hot weather to be acceptable to the majority of users.

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*Air Conditioning Engineer, San Antonio Public Service Company.
For presentation at the Fall Meeting of the AMERICAN SOCIETY OF HEATING AND VENTILATING ENGINEERS, Houston, Texas, Oct. 14-15, 1940.

[1] ASHVE Research Report No. 1127, Reactions of Office Workers to Air Conditioning in South Texas, by A. J. Rummel, F. E. Giesecke, W. H. Badgett and A. T. Moses (ASHVE Transactions, Vol. 45, 1939, p. 459).

[2] ASHVE Research Report No. 1136, Summer Cooling Requirements in Washington, D. C., and other Metropolitan Districts, by F. C. Houghten, Carl Gutberlet and Albert A. Rosenberg (ASHVE Transactions, Vol. 45, 1939, p. 577).

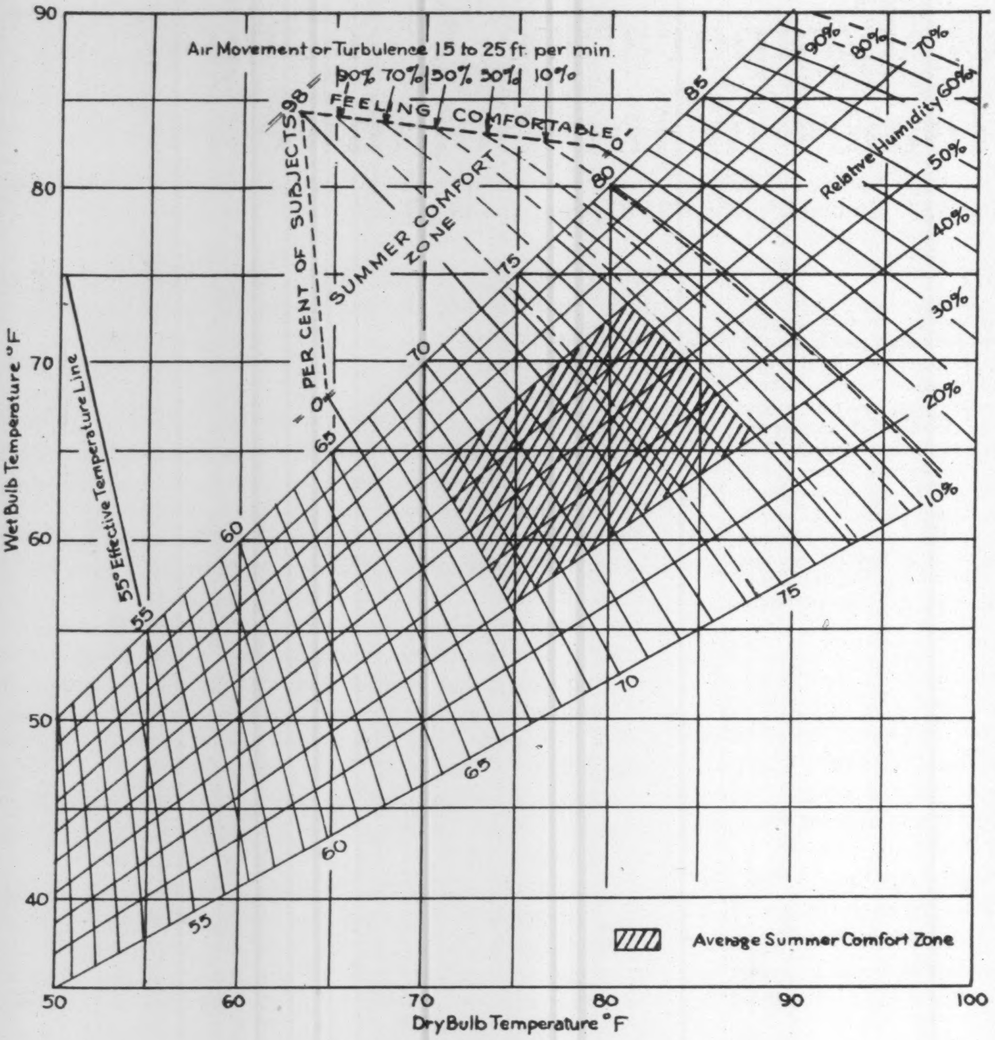


Fig. 1—Probable comfort chart for the Southwest

Since these conclusions are based on tests made with individuals in the territory where the desired optimum effective temperature is 2 deg lower than in the Southwest it appears logical to suppose that in the territory where direct evaporative cooling is effective the maintenance of indoor effective temperatures in the neighborhood of 76½ deg and lower might be acceptable to the majority of residential users as long as the relative humidity does not exceed the upper limit of the comfort zone. By referring to the probable comfort chart, Fig. 1, as prepared for the Southwest, it will be noted that at 76½ deg ET we might expect about 60 per cent of the people to feel comfortable in an air movement of from 15 to 25 fpm.

Consider a location in the Southwest where an evaporative cooling installation is operating under conditions of 75 F wet-bulb—the upper limit of wet-bulb where it is considered practicable to use this type of system. If the upper comfort zone humidity limit of 70 per cent is to be maintained with a 75 F wet-bulb, the dry-bulb temperature will be 83 F. By referring to the accompanying comfort chart, Fig. 1, it will be noted that under conditions of an air movement of 15 to 25 fpm—the average air movement in most air conditioned installations—and wet- and dry-bulb temperatures of 75 and 83 F, respectively, the effective temperature would be 79 deg. At this condition only 25 per cent of the occupants might be expected to feel comfortable.

Since it is not possible to obtain a lower dry-bulb temperature and still stay within the upper limit of relative humidity, the only alternative is to obtain a reduction in effective temperature by means of increased air movement.

It has been determined that in completely air conditioned buildings, if the air temperature is below 80 F dry-bulb, air movements exceeding 25 fpm have a tendency to produce a feeling of draft. However, when the air temperature is above 80 F, higher air velocities are possible without a feeling of draft and are desirable. By referring to Fig. 2 it will be noted that under conditions of 75 F wet-bulb and 83 F dry-bulb, to obtain an effective temperature of 76½ deg, it would be necessary to increase the air movement to approximately 200 fpm.

In an effort to determine whether or not home owners would be comfortable and satisfied under conditions of such high air movements, numerous investigations and personal interviews were made. In general, it was found that with the most common type of installation, where the air discharge was installed so that the air was introduced into the living quarters in a horizontal direction through a grille, the main objection was uneven air distribution. With this arrangement, when standing in the path of the air discharge a very high velocity of air was encountered while when out of the path of the air discharge the air movement was insufficient for comfort.

After a careful study of various reactions and objections had been made, an installation was planned in an effort to overcome as many of these objections as possible, and one that would result in the maximum comfort possible when operating under conditions close to the upper wet-bulb limit the greater part of the time.

The system installed for test purposes was made in a five-room frame cottage located in San Antonio, Texas. The installation was made so that the system could be operated with the windows and doors open or closed, with individual air supplies to each room, and with a humidistat to limit the moisture that would be added to the air.

The evaporative cooling unit itself was installed in the attic of the home as shown in Fig. 3. Individual galvanized iron ducts were run to the center of each room, terminating at the ceiling plaque, as shown in Fig. 4. In the ceiling of the central hallway there was installed a 3 ft by 6 ft exhaust grille having a net free area of 12.46 sq ft and in the kitchen, directly above the gas range, a 10 in. round vent with an area of 0.54 sq ft. Under the eaves of the house the cornice facing was removed and ¼-in. hardware screening installed; also, louvers were installed in the gables at each end of the house. A humidistat which was connected to a water valve supplying the water to the evaporative pads was placed in the central hallway.

The operation of the system was such that, with the windows and doors of the house closed, outside air was drawn through the wetted pads by a blower, after which the air was delivered to each room through the central ceiling plaque shown in Fig. 4.

The installation was made on the basis of a 700 fpm velocity through the ducts, and a 350 fpm discharge velocity from the ceiling plaque. The blower and cooler assembly was mounted on cork in the attic, and the 1 hp motor operating the twin blower was mounted on a floating base. The insides of all ducts delivering air to the rooms were lined with acoustical felt for a distance of two

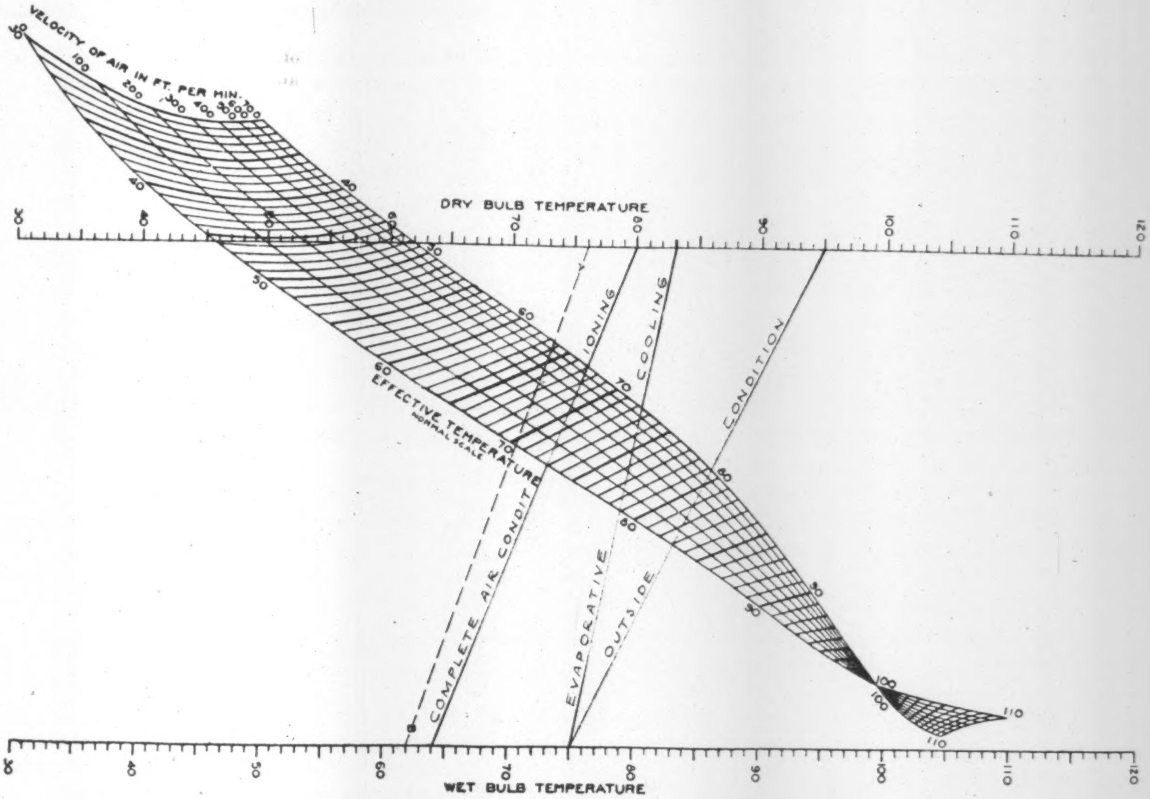


Fig. 2—Effective temperature chart

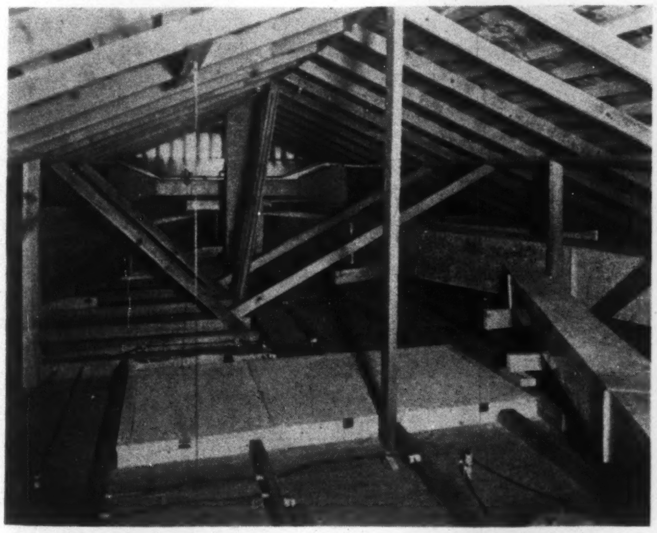


Fig. 3—Duct work in attic and opening in central hallway through which air enters attic

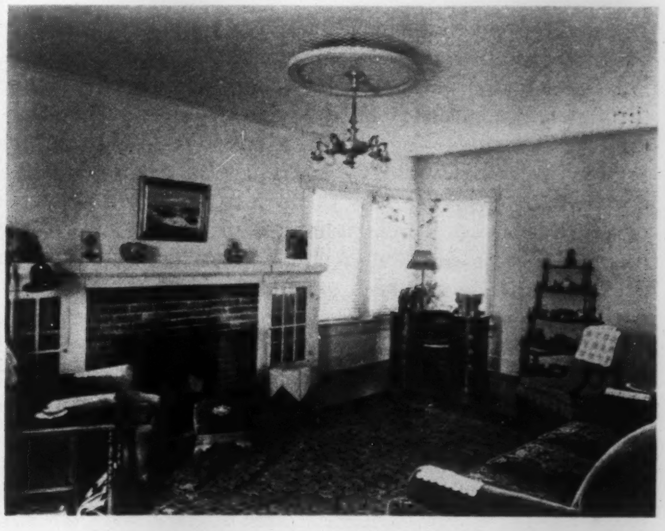


Fig. 4—Ceiling plaque through which air was introduced into living room

feet from the outlet of the fan. Although all equipment was installed in the attic, there was no objectionable noise or vibration when the system was in operation.

After the air which is drawn into the unit from outdoors has its dry-bulb temperature reduced, it is discharged into the room. When operating with all windows and doors closed, the pressure inside the house is naturally higher than that outdoors. Under these conditions the air, after passing through the rooms, is exhausted through the grille in the central hallway into the attic space and out of the attic, through the openings under the eaves of the house, to the outside.

The installation was completed and put into operation on July 17, 1939. Readings were taken with an anemometer at the exhaust grille in the hallway and kitchen with all windows and doors closed. The average velocity of the air at the hall grille was 388 fpm and at the kitchen grille 420 fpm. At these velocities the air being discharged into the attic space through the hall grille was 6903 cfm and through the kitchen vent 227 cfm, giving a total of 7130 cfm.

Since the volume of the house was 9300 cu ft and that of the attic 3600 cu ft, the air was being changed in the house every 1.3 minutes, and in the attic every one-half minute.

Static pressure readings taken on the inlet and outlet sides of the blower showed 0.12 in. of water and 0.13 in. of water, respectively, a total of 0.25 in. of water.

The flow of water to the evaporative pads was set at 0.78 gpm. The excess water was taken through a drain pipe on the outside of the house, as shown in Fig. 5, to the back of the house, where a garden hose was connected and the water used to water the lawn and garden.

A 1 hp single-phase motor rated at 6.3 amp and 220 volts was used to operate the twin blower. When the system was operating, as stated previously, readings taken showed that the motor was using 948 watts at 6 amp and 232 volts.

Temperature and humidity readings taken inside when the outside dry-bulb temperature was 94 F and the outside wet-bulb temperature 75 F were 83 F dry-bulb and a relative humidity of 70 per cent—the setting of the humidistat. The temperature in the attic during this same time was 87 F.

Readings were taken of the outside air wet- and dry-bulb temperatures as it entered the unit at the inlet louver and also of the air as it was leaving the house through the ceiling grille. These readings were taken under different outdoor weather conditions with the average result that on days when it was cloudy and the dry-bulb temperature was fairly low, the wet-bulb temperature increased approximately 0.6 F after having passed through the house, and approximately 0.8 F on days of sunshine and high outside dry-bulb temperatures but with approximately the same wet-bulb temperature.

On the basis of the increase in wet-bulb temperature of the air after passing through the house, the equivalent heat removal amounts to 1.45 and 1.97 tons of refrigeration, respectively.

In addition, the difference in heat flow from the attic space to the rooms below is greatly reduced. Attic temperatures in the location of this test are often as high as 140 F, and the difference in heat flow when the attic temperature is only 87 F amounts to a reduction of approximately 40,000 Btu per hour or the equivalent of 3⅓ tons of refrigeration.

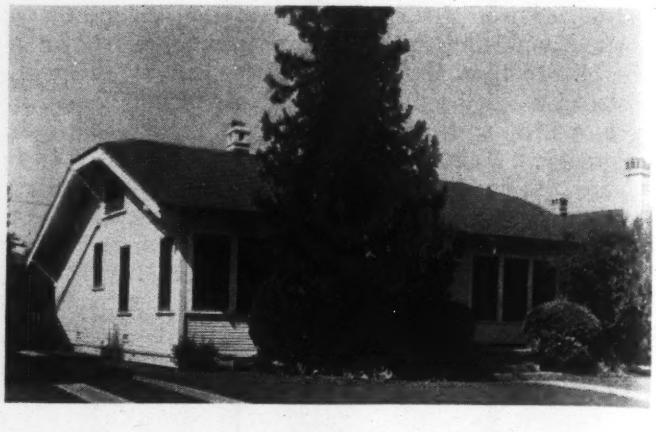


**Fig. 5—Exterior view of test house showing inlet louver to cooler and excess water drain**

Similar studies were made when the air flow was reduced until the amount of air leaving the house through the exhaust grilles was 5840 cfm and 3380 cfm.

The setting of the air flow at 7130 cfm and 5840 cfm was permitted to remain for several weeks and expressions of comfort from people who were in the house for long and short periods of time were tabulated.

The following is a summation of the personal reactions to the three air deliveries:

| AIR FLOW IN CFM | TIME IN MINUTES FOR ONE AIR CHANGE IN HOUSE | REACTION |
|---|---|---|
| 7130 | 1.3 | Comfortable |
| 5840 | 1.59 | Fairly comfortable with just a slight sensation of a too humid condition |
| 3380 | 2.75 | Uncomfortable |

An effort was made to determine the air velocity at different locations in each room. First a direct reading air velocity meter was used, but these readings indicated rather definitely that there was a considerable turbulent action of the air in all parts of the room. At points within one foot of the walls positive and negative readings were observed in three different directions. After it became evident that no definite measure of air movement could be determined with this instrument it was thought that a more average determination could be made by means of the anemometer. After several trial readings were taken, it was determined that the most positive readings could be obtained on the four walls of the room at the breathing level height. Even with these readings it was quite evident that the air movement as recorded was not the true air velocity due to the turbu-

**Table 1—Air Movement and Effective Temperatures in Test House With Direct Evaporative Cooling**

| ROOM | AIR MOVEMENT IN FEET PER MINUTE | | | EFFECTIVE TEMPERATURE 83 DEG DB—75 DEG WB 70% RH | | |
|---|---|---|---|---|---|---|
| | MAXIMUM | MINIMUM | AVERAGE | MAXIMUM | MINIMUM | AVERAGE |
| Living Room | 90 | 42 | 68 | 77.9 | 78.3 | 78 |
| Dining Room | 120 | 70 | 92 | 77.3 | 78.0 | 77.8 |
| North Bed Room | 115 | 60 | 88 | 77.5 | 78.2 | 77.9 |
| South Bed Room | 160 | 82 | 133 | 76.9 | 77.9 | 77.1 |
| Hall | 220 | 160 | 179 | 76.1 | 76.9 | 76.8 |

lent action of the air. This turbulent action was quite noticeable, since in standing in any part of the room one could feel air movement on all parts of the body.

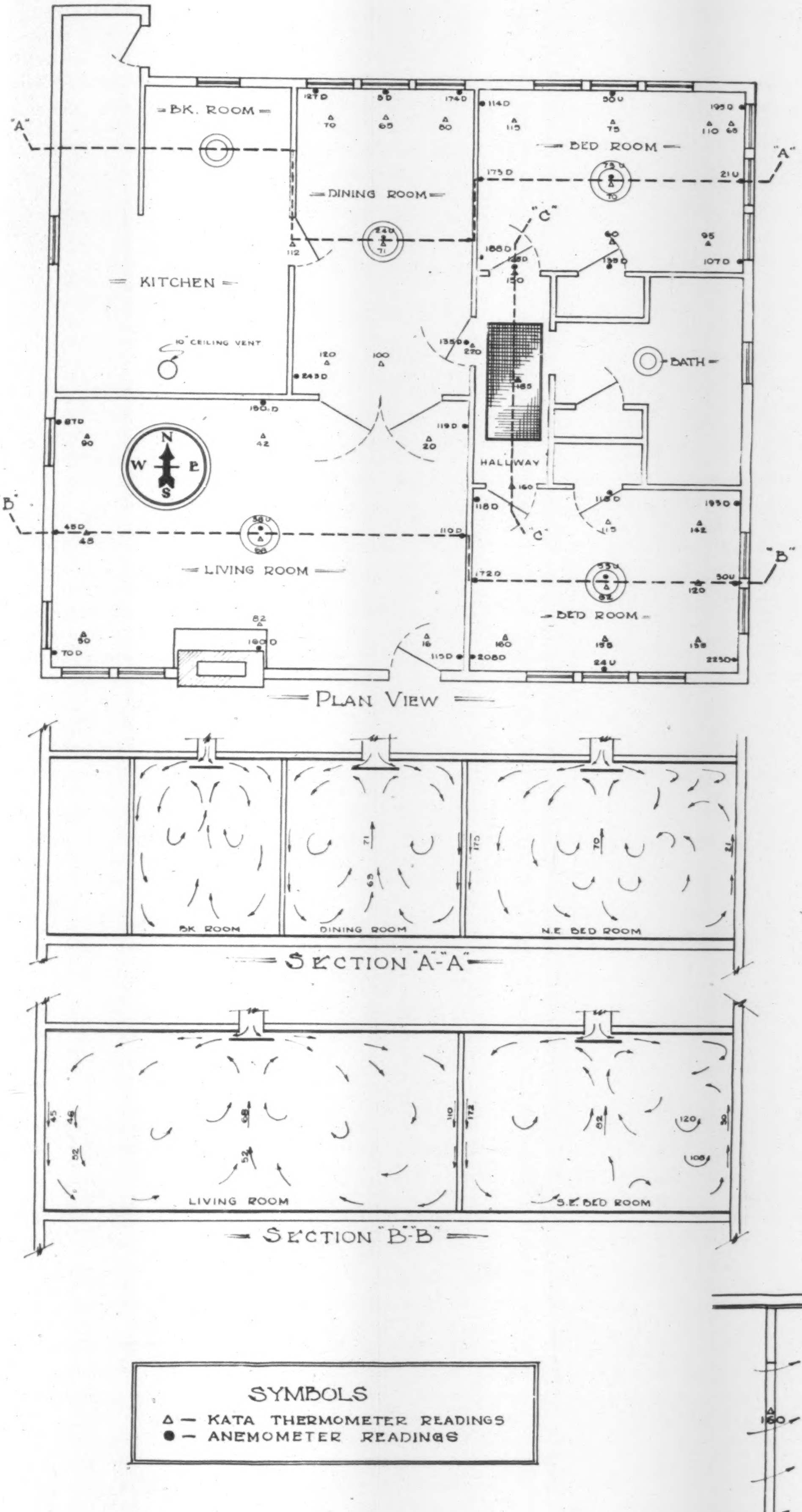
From the readings obtained it was found that only by using a Kata thermometer could a true reading of the air movement be obtained and accordingly a set of readings was taken with a Kata thermometer at a level 5 ft above the floor line. The average of these Kata thermometer readings taken at a distance of approximately 24 in. from the wall and the anemometer readings taken directly against the wall are shown in Fig. 6. These readings were taken when the air flow was 7130 cfm.

Another set of readings was taken at a level 3 ft above the floor and these readings showed a velocity about 10 per cent less than at the 5 ft level.

The accompanying Table 1 gives the average air velocity in each room with the corresponding effective temperatures as determined from the American Society of Heating and Ventilating Engineers Comfort Chart.

The results of these readings show that there is a variation in the effective temperature in different parts of the house from a minimum of 76.1 deg, corresponding to an air movement of 220 fpm, to a maximum of 78.5 deg, corresponding to a 42 fpm air movement with an average condition of 77.8 deg, corresponding to a 92 fpm movement.

To obtain a 76½ deg ET with an average air movement of 92 fpm at a 70 per cent rela-


BK. ROOM
DINING ROOM
BED ROOM
KITCHEN
10" CEILING VENT
BATH
HALLWAY
LIVING ROOM
BED ROOM
N
S
W
E
"A"
"A"
"B"
"B"
"C"
"C"
PLAN VIEW
BK ROOM
DINING ROOM
N.E BED ROOM
SECTION "A"-"A"
LIVING ROOM
S.E. BED ROOM
SECTION "B"-"B"
SYMBOLS
△ – KATA THERMOMETER READINGS
● – ANEMOMETER READINGS

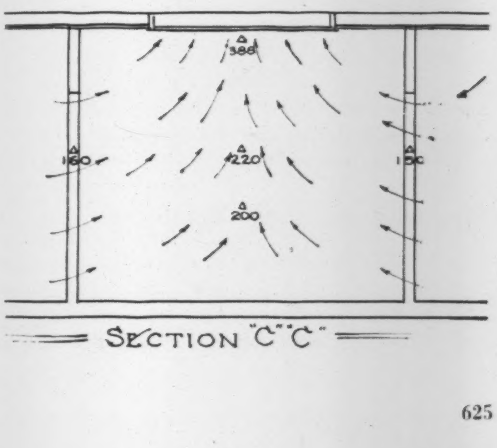

386
160
220
150
200
SECTION "C"-"C"

Fig. 6—Residential evaporative cooling—air velocity data

tive humidity, the indoor conditions should be approximately 73½ F wet-bulb and 81½ F dry-bulb.

It was noted that for those people who entered and remained inside the house the average condition was comfortable, with an increased comfort noted when in the hallway, where the air movement was the highest, with no objection to the higher air movement.

The results of these investigations and tests indicate rather conclusively that in this locality the conditions that can be obtained, when the installation is made and operated as previously described, will prove satisfactory to the average home owner. However, it is felt that the conditions obtained in this investigation are about at the upper limit of comfort conditions, and any condition of higher indoor effective temperature would not be acceptable.

Since this method of comfort cooling has shown such an increase in public interest during the past few years, it appears that more definite and authoritative information should be made available for this phase of comfort cooling. In this connection it is recommended that further studies be made of similar installations in localities having lower wet-bulb temperatures with the ultimate preparation and adoption of some Standards for the Cooling of Residences by Simple Evaporation.

## Special Meeting at Minnesota

On August 26, members of the Minnesota Chapter joined with members of the Minnesota Association of Professional Engineers and the Minneapolis and St. Paul Engineer Clubs for a very enjoyable day of activities. N. D. Adams was general chairman of arrangements.

Despite rainy weather, approximately 125 engineers and their wives and friends attended the meeting, which was held at the Country Club, Rochester, Minn. A large number participated in golf, bridge, trap-shooting, and bowling during the afternoon.

The main program of the evening was broadcast through Station *KROC*. The speaker was Lieut. R. B. Warren of the Corps of Engineers of the United States Army, and his subject was "The Engineer and National Defense."

Greetings were extended by Mayor Paul Grassle, Dr. C. W. Mayo of the Mayo Clinic, and S. P. Allen, president of the Chamber of Commerce.

## National Roster of Engineers

The National Resources Planning Board has been authorized to prepare a national roster of scientific and specialized personnel under the leadership of Dr. Leonard Carmichael, president of Tufts College and chairman of the Science Committee, on which there are representatives from the Social Science Research Council, the National Research Council, the American Council on Education and the Council of Learned Societies.

At a conference at the Engineering Societies Building on September 6, Dr. John S. Nicholas, chairman of the Committee of the National Research Council, outlined to the representatives of 13 national engineering societies the method of preparing the roster and invited their cooperation to establish a technical check list to be used for evaluation of the special scientific, technical or administrative abilities of engineering personnel.

## Standard for Pipe Nipples

A revised commercial standard covering brass, copper, steel and wrought-iron pipe nipples has recently been adopted by the Department of Commerce through the National Bureau of Standards. The code covers steel, ferrous-alloy and wrought-iron pipe nipples, black and zinc coated in iron pipe sizes from ⅛ to 12 in., inclusive, of standard lengths and brass and copper nipples in standard sizes from ⅛ to 6 in., inclusive of standard lengths. Ferrous-iron pipe nipples are to be furnished in standard weight, extra strong and double extra strong; and brass and copper nipples are to be furnished on the basis of standard weight and extra strong.

Copies of this standard may be secured through the Superintendent of Documents, Washington, D. C., for 5 cents a copy and may be referred to as Commercial Standard CS5-40.

## Corrosion Inhibitors for Air Conditioning Equipment

Corrosion protection in air conditioning equipment is of great importance and if suitable precautions are not taken to guard against the losses from corrosion, many parts of the system become badly corroded and require replacement within a short time. This is especially true in industrial regions, where the normal contamination of the air with acid-forming gases, as oxides of sulfur and carbon, is relatively high. The presence of chlorides in the atmosphere of some localities is also conducive to corrosion.

Painting the equipment to prevent its deterioration is often resorted to, but this is not entirely satisfactory, since corrosion occurs at breaks in the paint film and serious damage to the metal parts may result before it is visible to one inspecting the setup. There are also parts which it is not feasible to paint, such as the interior of the pipes or other inaccessible parts.

To investigate the problem suitable apparatus was arranged so that the water could be treated by the addition of chemicals which would inhibit the corrosive attack. Six ferrous sheet materials were used in the test consisting of a copper-bearing steel, an open-hearth iron, an alloyed open-hearth iron, a low-alloy steel, a wrought iron of the new *synthetic* type, and a hand-puddled wrought iron. Although some differences in the behavior of the various materials were observed, as a result of water treatment, the results were not considered great or consistent enough to constitute a significant factor affecting the conclusions.

In general the study disclosed a number of generalizations on the corrosive properties of water which were treated with small amounts of corrosion-inhibiting chemicals and some of the more important trends observed are mentioned herewith:

1. All of the inhibitors tested, with the exception of 100 ppm of sodium carbonate, decreased the rusting of iron or steel.

2. The order of decreasing efficiency of the inhibitors studied in the concentrations used, was (*a*) chromates, (*b*) silicates, (*c*) phosphates, and (*d*) carbonates.

3. In the case of the sodium silicates tested, the results indicated that the higher the ratio of silicate dioxide to sodium oxide, the greater was the inhibiting action.

4. Although some differences were noted in the initial corrosion resistance of the various kinds of iron and steel used, in most cases this was slight in comparison with that produced by a change in the inhibitor than it was in its absence.

6. In the case of all the inhibitors used, corrosion to some extent occurred in crevices but it failed to occur on flat, uniformly exposed metal surfaces in two instances. However, with inefficient inhibitors, the rusting was less in the crevices than on the fully exposed surface. In this case, the amount of corrosion appeared to be a function of the available space with the crevice.

More complete information pertaining to this study may be referred to in the article Tests of Corrosion Inhibitors for Water Treatment in Air-Conditioning Equipment by James H. Wilson and Edward C. Groesbeck (Research Paper RP1305), which may be obtained through Superintendent of Documents, U. S. Government Printing Office, Washington, D. C., for 5 cents per copy.

# Chemical Dehumidification Agents

By F. R. Bichowsky,* (*MEMBER*), Ann Arbor, Mich.

## SUMMARY

**Selection of a drying agent for chemical dehumidification requires consideration of several balancing factors. A comparison of various solid absorbents is given showing amount of water absorbed at varying relative humidities. Equipment suitable for the use of solid absorbents is described utilizing the stationary and movable bed principles. Engineering data are outlined for absorbents in solution and concentrations necessary to maintain constant relative humidities. Means of combining dehydration with evaporative cooling, with refrigeration and with solvent recovery make possible a great number of combination systems where dehydration may be used.**

AGENTS that can be used in the chemical dehumidification of air fall generally into one of three classes. (1) Agents that remain solid in contact with air at all operating conditions. This class includes such agents as silica gel, activated alumina, lime, copper sulfate and many others. (2) Agents that change from solid to liquid in contact with wet air. Such agents are calcium chloride, phosphorous pentoxide, and lithium chloride under some conditions. (3) Agents that are liquid under the drying conditions at which they are used. Such agents are sulfuric acid, phosphoric acid, glycerine, diethylene glycol and under ordinary conditions solutions of lithium chloride, lithium bromide and various salt mixtures.

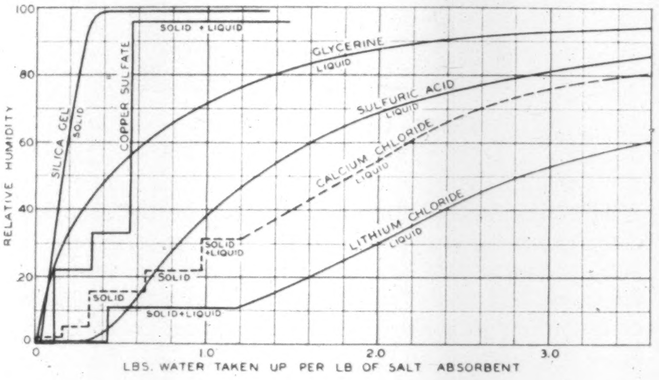


**Fig. 1—Comparison for various solid absorbents**

No one of these agents is ideal for every purpose and the first problem of the air conditioning engineer in considering the advisability of using chemical dehumidification is to choose the correct agent. The choice of the correct agent requires the balancing of several factors against each other. These factors are: The thermodynamic suitability of the agent which includes its vapor pressure and phase relationships; its engineering suitability which includes its heat and moisture transfer coefficients; its viscosity if a liquid, its volume stability if a solid; its chemical suitability which includes its stability and corrosiveness; its physiological suitability which includes its odor and toxicity; and last but not least, its economic suitability which includes its cost and the cost and availability of apparatus adapted for its use, and the operating and maintenance of such apparatus.

As a rough approximation true for all absorbents the relative humidity of air in equilibrium with the absorbent is independent of the temperature but depends on the nature of the absorbent and on the amount of water that it has taken up. Thus, a plot of the relative humidity of air in contact with an absorbent against the water content of the absorbent gives a convenient means of comparing the thermodynamic suitability of various absorbents. More accurate methods will be discussed later. Such a comparison for the various solid absorbents is shown in Fig. 1.

It will be seen that they fall into two classes (1) Those characterized by step like curves called chemical absorbents. The step shape of the curve is due to the fact that a mixture of two solid hydrates has the same vapor pressure regardless of the proportion of each present. There are a great many chemical absorbents available. They are particularly useful where it is desired to maintain a small body of air at a fixed relative humidity without the need of expensive apparatus. These materials can also be used in more elaborate installations but there is at present no manufacturer offering the necessary equipment.

(2) Solid absorbents which are the capillary absorbents often though inappropriately called gels. This class, of which activated alumina and silica gel are typical, are supposed to depend for their absorbing power on the capillary condensation of liquid water in their extremely fine pores. Since the pores in a gel are of more or less random size such substances are characterized by a smooth probability shaped characteristic curve.

Thus such substances can produce air of any relative humidity depending on the amount of water they have already taken up in their pores. In order to use a gel to maintain air at a given relative humidity it is necessary to maintain the composition of the gel constant which is sometimes difficult to do. Theoretically, therefore, this type of absorbent is not suitable in installations where very close control of humidity is required. In

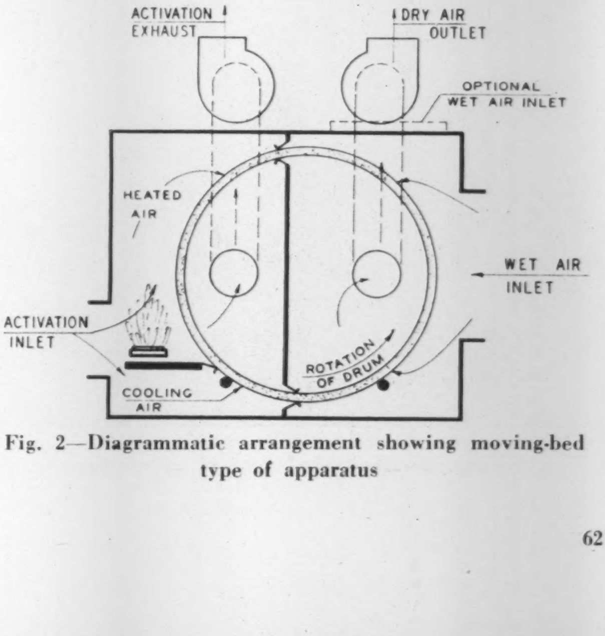


**Fig. 2—Diagrammatic arrangement showing moving-bed type of apparatus**

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For presentation at the Fall Meeting of the American Society of Heating and Ventilating Engineers, Houston, Tex., October, 1940.

practice, by use of instrumental control, this theoretical difficulty can be minimized.

The apparatus for use of solid absorbents which is now commercially available falls into two classes; that in which the bed of absorption remains stationary and that in which the bed moves.

In the moving-bed type of apparatus, shown in Fig. 2, a single drum of absorbent moves progressively into a zone where it is heated and dried out, then into a cooling zone and finally into an active zone where it absorbs moisture from the air passing through it. Apparatus of this type has the advantage of simple construction, moderate cost, simple operation and low pressure drop. It is eminently suitable for small installations.

As shown in Fig. 3, it is impracticable in a moving bed to remove the heat of absorption at the place where it is produced in the bed. For this reason apparatus of this type is always operated adiabatically. That is the latent heat of absorption (about 1200 Btu per pound) is transferred to the air which leaves the bed at temperatures ranging up to 140 F. In some drying operations the hot, dry air thus produced can be used directly, but usually the apparatus is provided with an after cooler which serves to cool the dry air to a suitable temperature.

The most important limitation of this class of apparatus is not the after cooler for it is a technical advantage to be able to remove the heat of absorption at high temperature level, but the fact that in the design of equipment of this type certain compromises have to be made which for some purposes lower the thermal efficiency of the cycle, increase its operation cost and complicate the control. The most important of these compromises concerns the thickness of the bed. The very thick bed would have high air resistance and hence the cost of operation of the apparatus would be high due to the high power requirements inherent in blowing air through a thick bed of absorbent. On the other hand, it is desirable to have a thick bed in order that the efficiency of the apparatus be high; that is, in order that a large proportion of the moisture be taken out for a single pass of the air. For the normal type of air conditioning installation where dry air is not required and where costs of moving and where noise are important factors, it is desirable to keep the bed as thin as practicable, even at the expense of lowering the efficiency of the apparatus. But there are industrial applications for drying where it is desirable to circulate less air and to dry it nearly bone dry. In cases of this sort it is advantageous to have a thick bed.

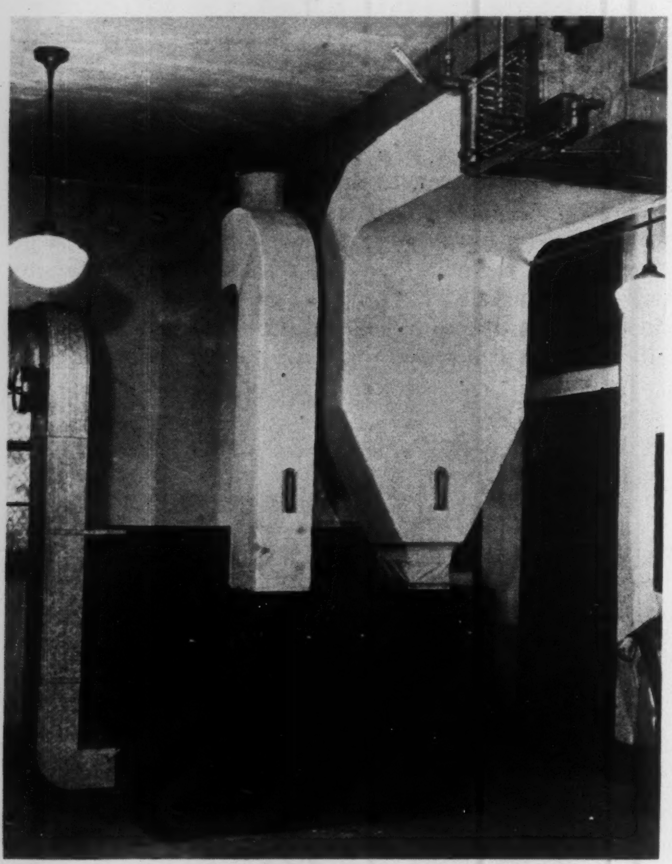

Fig. 3—Moving-bed type of apparatus

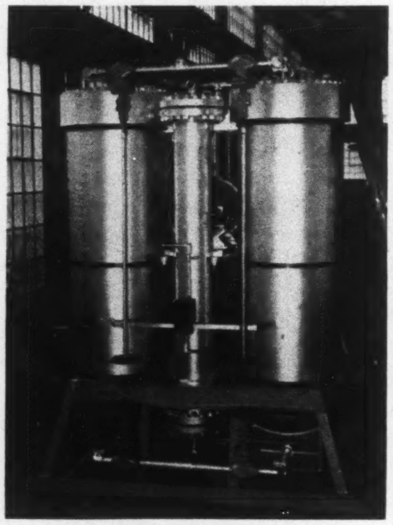

**Fig. 4—Commercial apparatus employing two-bed principle**

The second class of equipment using heated absorbents employs a stationary bed. In its simplest form only two beds of absorbents are used, the air being transferred from one bed to the other according to a fixed schedule or according to some sort of temperature control. This type of apparatus with two beds is very suitable for the drying of air at high pressures and for other cases where the semi-intermittent nature of the drying process is not objectionable. Commercial apparatus employing the two-bed principle is illustrated in Fig. 4. It is also possible using solid stationary beds to accomplish essentially the same cycle as is employed in the case of the moving beds by leaving the drum or ring of absorbent stationary and moving the air streams so that each part of the absorbent is exposed successfully to a blast of hot air, to a cooling blast and then to a blast of air to be dried. These successive operations can be controlled by a series of air valves or more naturally by rotating an air directing means from bed to bed. An advantage of thus moving the air rather than the absorbent is that it is possible to imbed in the absorbent cooling and heating coils thus eliminating the need of an after cooler and thus making possible the use of steam as a source for the regenerating heat. The use of an imbedded cooler may or may not be an advantage, but the possibility of using steam for regenerating is, in many cases, of considerable commercial advantage. Apparatus of this type is shown in Fig. 5.

### Mixed Type of Absorbents

Calcium chloride is typical of the mixed type of absorbents. As is shown in Fig. 1, the curve of relative humidity against water content is characterized by a step-like section followed by a curved section. The first steps represent calcium chloride acting as a typical chemical absorbent, that is, as a mixture of solid hydrates. The last step represents a mixture of the hexahydrate and the saturated solution. The third or smooth part of the curve gives the relative humidity of air over an unsaturated solution. Thus calcium chloride can theoretically be employed in three separate ways. It can be employed in the portion of the curve where no liquid is formed; it can be employed as a mixture of solid and saturated solution, or it can be employed in the liquid range. Chemists frequently employ calcium chloride to complete the drying of air which has already been pre-dried to a relative humidity below 30 per cent. Under these conditions the anhydrous solid will take up moisture forming in succession the mono-di-tetra-and hexahydrates. In forming these hydrates a considerable increase in volume takes place, so space has to be allowed for expansion, but no liquid is formed if the relative humidity of the entering air is less than 30 per cent. It would be fortunate for the manufacturers of calcium chloride if in the larger field of air conditioning one could count on relative humidities remaining below 30 per cent for then calcium chloride could be generally used as a chemical absorbent for which, under these limited conditions, it is eminently suitable. But in the usual air conditioning problems where the relative humidity of the inlet air exceeds 30 per cent a complication comes in, namely, that whenever the relative humidity is above this critical value the surface of the granules of calcium chloride become successively converted through the various hydrates and finally when all the surface has been converted to the hexahydrates, additional water taken up converts the surface into a saturated liquid. The solid deliquesces. The saturated liquid thus formed on the surface seals the pores of the solid hydrate and therefore the inside of the solid chunk of absorbent becomes ineffective. Of course, if enough liquid has been formed, it will drop away and new surfaces will thus be exposed which by this means will be kept constantly wet and of the same composition.

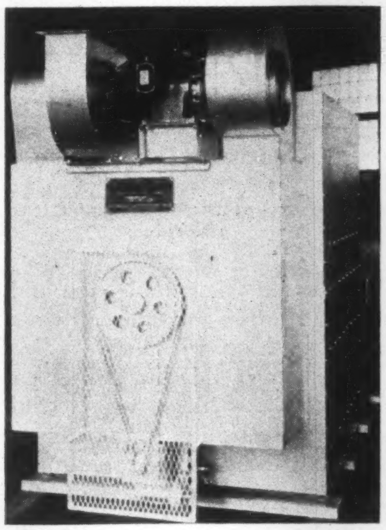

**Fig. 5—Apparatus showing imbedded cooler**

This is both an advantage and a disadvantage. Because the composition of the solution is thus maintained constant, the air leaving contact with it tends to maintain very closely a constant relative humidity which is a real advantage, particularly in laboratory apparatus where it is desirable to maintain a sample of air at a fixed relative humidity.

It is a disadvantage in that means must be provided to take care of the drip thus formed and to dispose of it. Fig. 6 shows crude apparatus suitable for drying storerooms and for places where the load is not high.

The chief limitation of this method of drying air is the bother and cost of replacing the solid absorbent and disposing of the drip. Nevertheless this method of dehydration deserves to be more widely used especially for apparatus used only occasionally and in cases where the first cost of equipment is more important than the refinement of operation or operating costs. Regeneration of the drip would be theoretically possible, but it is not ordinarily practical, not because one cannot boil calcium chloride solution to dryness, but because of the bother of cooling, crushing, grading, and loading the salt.

The third portion of the curve for calcium chloride of relative humidity against water content represents air in equilibrium with a solution of given composition. This portion of the curve is smooth; that is to say, the relative humidity of air in equilibrium with the solution can have any value between 100 per cent and the limit representing the relative humidity of the saturated solution. Thus, by controlling the composition of the solution it is possible to control the relative humidity of the air to any value that is desired very accurately. This is an important advantage where accurate control of humidity is required.

The use of mixed absorbents in the liquid range has other advantages. It is possible to use liquid absorbents much as one would use solids disbursing them in trays in contact with the air dried. The common laboratory desiccator uses sulfuric acid in this way. It is more natural, though, to take advantage of the fact that one can pump the liquid absorbent from place to place and thus use systems where the liquid is circulated rather than where it remains stagnant in trays.

The use of circulation introduces some direct limitations in the choice of absorbents. The most important of these arise from the very different characteristics exhibited by various absorbents of the mixed type at their point of crystallization. This can be illustrated by contrasting the phase diagrams of calcium chloride and lithium chloride shown in Figs. 7 and 8.

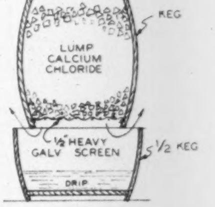

**Fig. 6—Crude apparatus suitable for drying storerooms and for places where load is not high**

A phase diagram is a plot of the vapor pressure (on a logarithmic scale) against the composition of the solution. The field of curved lines represent the vapor pressure (and equilibrium relative humidity) for all temperatures and composition of so-

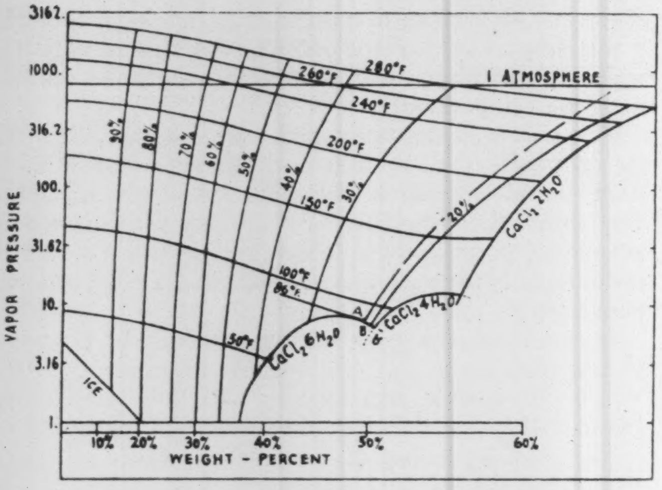

Fig. 7—Phase diagrams of calcium chloride

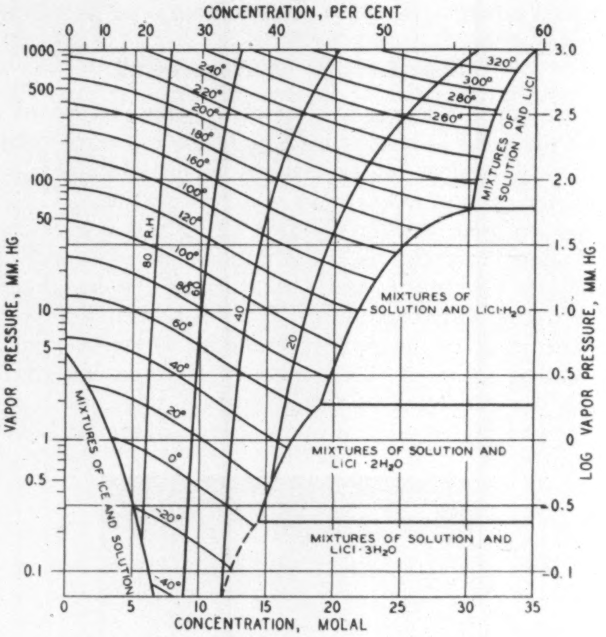

Fig. 8—Temperature—pressure—concentrations for lithium chloride

lution. The boundary lines of the field represent the vapor pressure and relative humidity of the saturated solution.

Beginning with a solution of calcium chloride at a temperature of 100 F and with a composition of 45 per cent, one can read off the chart the vapor pressure of the solution and the relative humidity of the saturated air in equilibrium with it. These vapor pressures and relative humidities would make it entirely practicable to use calcium chloride at this temperature and concentration in many air conditioning comparisons. Now consider what happens if the temperature of the solution should fall to 86 F as might readily occur during the night. At 86 F the 40 per cent solution is saturated and crystals of the hexahydrates begin to form. If the temperature falls still further to 84 F, the solution will still remain saturated but the composition will change because the calcium chloride separating has a different composition than the solution. In this case the solution will become stronger. In general the composition of the solution will change in a direction that will allow the point representing the saturated solution to follow down the line of saturation. In this case, as the temperature falls the composition of the remaining solution will follow the curved portion marked *AB* on the chart. Eventually at a temperature of 82 F the solution will reach a composition called the eutectic composition and temperature, at which temperature the solution will freeze completely. This eutectic composition, which always lies at the bottom of a valley in a chart of this kind, is given by the point *B*. Though this sounds like a very technical matter, it is very important practically, for unless precautions are taken so that the calcium chloride solution in the circulating system never falls below the eutectic temperature, there is a danger that the entire system will become filled with a solid crystalline mass of hydrates, no liquid being left over. This has happened in actual installations and this possibility represents an important limitation of the use of calcium chloride solutions at high concentrations. It need not be a fatal limitation provided the precaution is taken of designing the system so that the solution drains into a sump on shutting down and so that means are provided for melting any crystals that form in the sump. When properly used, calcium chloride solutions are very suitable for many air conditioning problems, especially in adiabatic operations where it is not necessary to cool the solution.

Table 1—Comparative Characteristics of Various Absorbents

| | LiCl | $CaCl_2$ | $ZnCl_2$ | Mixture[a] 1 | Mixture[b] 1 | $H_2SO_4$ | Glycerine |
|---|---|---|---|---|---|---|---|
| Relative humidity at 90 F of saturated solution, per cent | 11 | 21 | 5 | 3 | 9 | 0 | 0 |
| Relative humidity at 60 F of saturated solution, per cent | 14 | 37 | 6 | 7 | ? | 0 | 0 |
| Eutectic Temperature, deg Fahr | —90 | +82 | —47 | Low | Low | Low | Low |
| Heat of dilution Btu per pound | 200 | Same | Same | Same | Same | Same | Low |
| Water capacity per cent relative humidity at 20 per cent relative humidity | 3 | 2 | 3 | 1 | 1 | 3 | 0 2 |
| Absorption coefficient | Approximately the same | | | | | | ? |
| Viscosity | Approximately the same | | | | | | |
| Electrolytic corrosion | Bad | Bad | Bad | Bad | Bad | Bad | None |
| Oxidation corrosion (compared with water) | Same | Same | Same | Worse | Worse | Same | Less |
| Acid corrosion | None | None | None | None | None | Bad | None |
| Chemical stability | Stable | Stable | Hydrolyzes | ......... | ......... | Stable | Oxidizes |
| Toxicity (to foods) | None | None | Unsafe | Doubtful | Doubtful | Unsafe | None |
| Cost | High | Low | Low | High | Moderate | Low | Moderate |
| Odor removed | Fair | Fair | Fair | Fair | Fair | Bad | Poor |

[a] Eutectic mixture of calcium chloride, calcium bromide, lithium chloride, and lithium bromide.
[b] Eutectic mixture of calcium chloride, and bromide.

Consider now lithium chloride used in the equivalent range; *e.g.* to produce air of 20 per cent relative humidity and 100 F. If such a solution is cooled, it will not begin to crystallize until the temperature of 40 F is reached and the whole solution will not go solid until —90 F is reached, which, of course, is equivalent to saying never in ordinary practice.

But this can be put in another way. The minimum safe design relative humidity that can be obtained with a given absorption solution depends not only on the actual temperature at which the solution is to be used, but also on the lowest temperature to which the solution is exposed. Table 1 gives these safe design relative humidities for various absorbents based on the assumption that the apparatus will not be exposed to temperatures below 60 F. Clearly this limitation is absent for true liquid absorbents such as sulfuric acid and glycerine. But unfortunately the true liquid absorbents have other limitations so that it has not been possible to employ them widely.

Another limitation on the use of solutions comes in connection with the regenerating process. Indeed, it is the regenerator which usually needs most critical design. There are several ways in which a solution can be concentrated without heating. The simplest is to throw away part of the solution and add more of the solid or liquid absorbent as make-up. This is entirely practicable where the make-up substance is cheap as in the case of calcium chloride or where the spent solution can be used elsewhere as is often the case with sulfuric acid. There are other ways of concentrating the solution such as electrolysis or freezing, but in the average plant the regeneration of the solution is accomplished by heating it and evaporating off water in an air stream or by boiling at atmospheric or reduced pressures. Fig. 9 shows two regenerators used in connection with comfort cooling.

The various absorbents behave quite differently in connection with this boiling process. In the first place, at these high temperatures there is a tendency for some absorbents such as zinc chloride, aluminum chloride and magnesium chloride to break down, giving off hydrochloric acid. Other absorbents, especially the organic absorbents, tend to crack or oxidize at these temperatures, forming such a product as acrolein which has a very pronounced odor. In the second place, at these high temperatures, corrosion is likely to be very much greater and electrolytic action more serious. All the liquid absorbents in commercial use are electrolytes, and therefore must be used in apparatus which is protected from electrolysis by avoiding the use of dissimilar metals in contact with the solution. Contrary to what might be expected these highly concentrated salt solutions are not extremely corrosive against the ordinary materials of construction. In the concentration regularly used they are usually less corrosive than pure water and much less corrosive than weak solutions of the same salt. Hence, no particular precautions are necessary, except to avoid electrolysis in parts of the apparatus which are used at room temperatures, though it is usually good practice to paint all exposed piping to prevent external rusting. Inhibitors such as sodium chromate can be used, but care should be taken in their selection, lest at the high temperatures of regeneration they are destroyed.

There are some special materials which should not be used in the construction of apparatus using the various absorbents for special reasons. Among these are magnesium alloys, at least with lithium chloride, and leather which for some reason yet unknown, becomes unusually hard and brittle, as many a worker has found out, to his disgust, when he stepped into a puddle of lithium chloride solution with leather shoes. The special problems of material which come in connection with regeneration must in general be left to the judgment of the manufacturer, but in the case where the regeneration is done at low temperature as in vacuum boilers, and on air regenera-

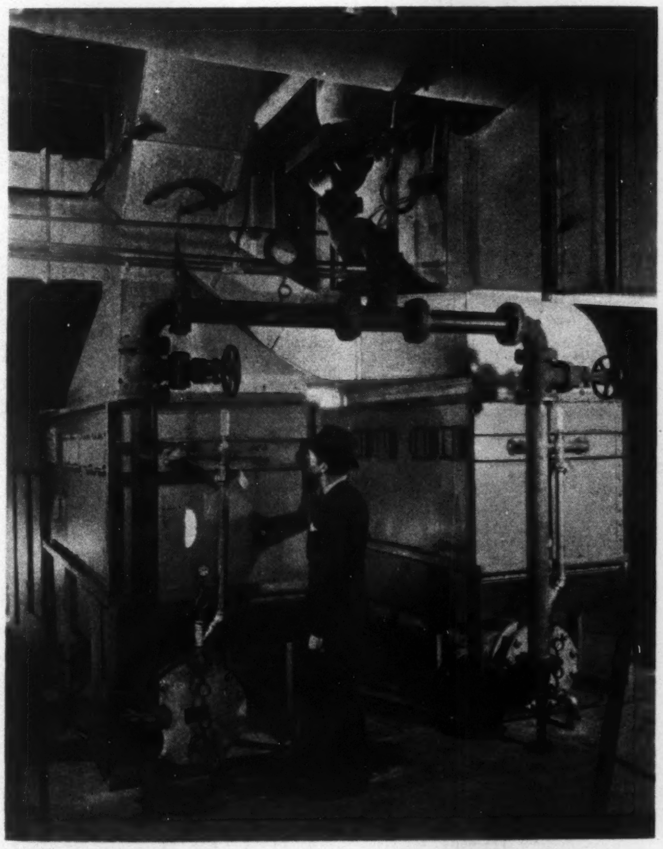

**Fig. 9—Two regenerators used in connection with comfort cooling**

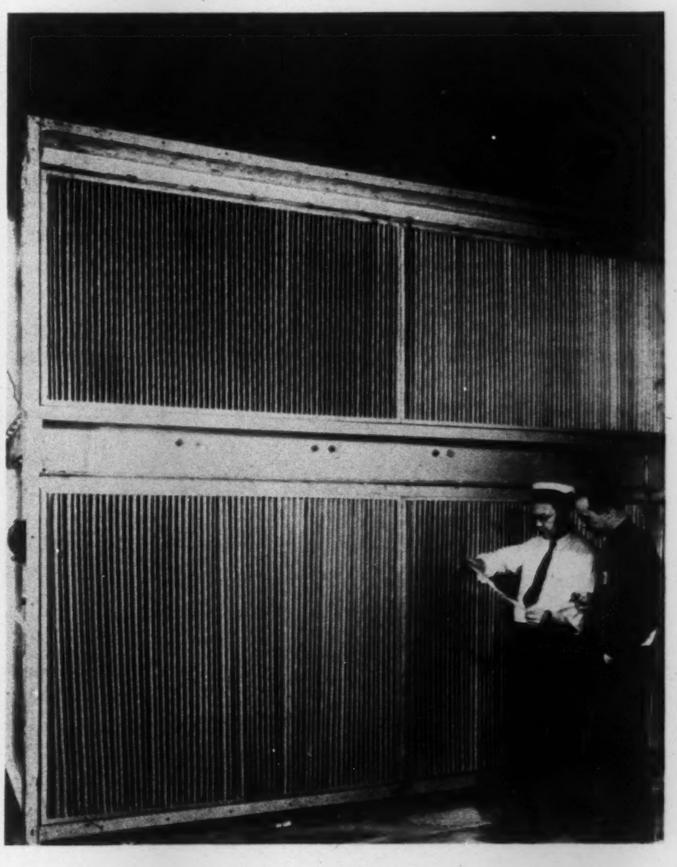

**Fig. 10—Plate-type air drier used in a large remote type installation**

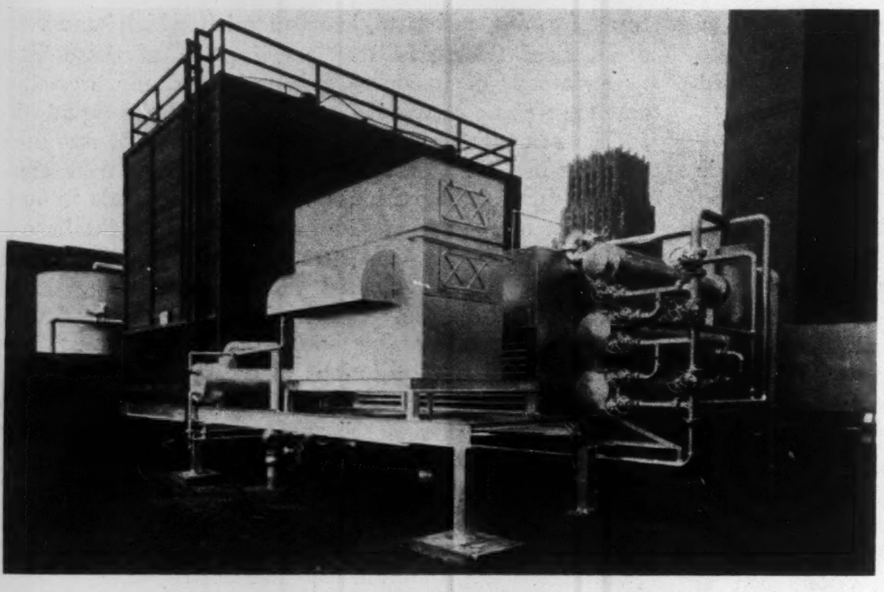

Fig. 11—A modern installation showing cooling tower, regenerator, contactor and cooler

tors, iron has proved an entirely satisfactory material for lithium and calcium chlorides and bromides.

Having decided on the class of absorbent to be used and having in mind the limitations fixed by the nature of the absorbent, the engineer intending to use liquid absorbent in connection with an air conditioning problem will be embarrassed by the great variety of possibilities that the use of liquids opens up. The limitations on apparatus for use on solid absorbents restrict the application of solid absorbents to rather limited fields but this is not so where liquids are employed, for the use of liquids makes possible a great variety of apparatus not available with solids. In the first place, with liquids one is not restricted to unit installations, since liquid absorbents can be pumped from place to place, and since it is possible to separate the regenerator from the air treating apparatus. It is also possible to serve more than one air treating apparatus from the same regenerator, and therefore it is possible to hang up small unit driers from the ceiling in various parts of a large factory and serve them all from a regenerating place located at some convenient point. A plate-type air drier used in a large remote-type installation is shown in Fig. 10.

It is also possible to use a variety of ways for removing the heat of absorption. It is not necessary to use absorptive solutions adiabatically as they may be cooled prior to contact with the air to a point where they will remove the heat of absorption, leaving the temperature of the air unchanged. Or they can be further cooled removing both the heat of absorption and some of the sensible heat in the air, thus cooling the air as well as drying it. Or they may be used to heat the air which is an advantage in some installations.

The cooling of the solution may be done in a standard tube-in-shell interchanger, or the solution may be cooled at the same time it is contacted with the air by trickling it over a finned cooler thus cooling the solution and contacting it with air at the same time. Fig. 11 shows a modern installation. There are also various ways of combining dehydration with evaporative cooling, with refrigeration, and with solvent recovery, making possible a great number of combination systems where dehydration is used in connection with other air conditioning processes. It is impossible in this paper to even indicate the various possibilities which the use of chemical dehumidification opens up for the air conditioning engineer. Indeed, in spite of the great success dehumidification has had in practical applications, the full possibilities of this tool have been only slightly explored. There are well over 200 installations now using chemical dehydration, the fields ranging from domestic air conditioning, through commercial air conditioning to industrial installations in a great variety of types and sizes. One of the most important needs in this field is an adequate study of the complete theory of dehydration and all its possible applications, so that the engineer will have a factual basis for the choice of equipment. This paper is intended as an introduction to the more detailed papers on the theory of dehydration, which will follow.

# Prof. John E. Emswiler Dies at Ann Arbor

After a year's illness Prof. John E. Emswiler, chairman of the mechanical engineering department, University of Michigan, Ann Arbor, died September 23, 1940, at the age of 60 years.

Professor Emswiler was born at Lebanon, Ill., February 13, 1880, and graduated from the Ohio State University in 1903 with a degree of B.S. in mechanical engineering. His professional experience began with the C. & G. Cooper Co., engine builders of Mt. Vernon, Ohio, and he did special work for the General Electric Co., Schenectady, N. Y., the Jeffrey Mfg. Co., Columbus, Ohio, and the American Blower Co., Detroit. In 1906 he joined the staff of the University of Michigan as instructor in the department of mechanical engineering. For a number of years he was engaged in experimental work and research chiefly dealing with power plant and heating and ventilating subjects.

Professor Emswiler served on a great many Society Committees and contributed numerous papers to its TRANSACTIONS, and compiled important data for THE GUIDE. He was the author of a text book on thermodynamics and many University bulletins.

Professor Emswiler joined the Society in 1917 and always took an active interest in its research work. His interests in activities covered a wide range in the fields of steam heating, boiler, radiator and fan testing, air friction in ducts, and natural and mechanical ventilation for public and industrial buildings.

His many friends in the Society will regret to learn of his untimely passing and the Officers and Council extend their sincerest sympathy to his family who survive.

Fig. 1—General view of laboratory for Technical Hygiene at the Government Graduate School of Engineering, Bandoeng

## SUMMARY

**A laboratory for air conditioning research has been established at the Technical University in Bandoeng in order to study the comfort requirements of the tropics. Comfort charts for typical cities in Java are presented with a discussion of the effects of tropical heat on individuals from temperate climates. The wider use of air conditioning in tropical climates needs to be explored more extensively through scientific research, according to the author**

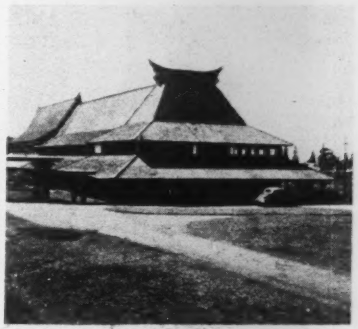

Fig. 2—Photograph of laboratory building

# Air Conditioning in the Tropics

By C. P. Mom*, Dr. Ir.
Bandoeng, Netherlands East Indies

LIVING comfortably in the tropics has presented a baffling problem to mankind for centuries, but the scientific advances of the last decade have improved conditions materially for those who leave the temperate zone to live and toil near the equator. The introduction of air conditioning for comfort has brought demands for specific information on its application in hospitals, homes and various industries.

During 1940 the facilities for the Laboratory for Technical Hygiene at the Technical University in Bandoeng were extended by the addition of a department for air conditioning research. Special aspects of the treatment of air in the tropics are being investigated in a new two-story building (Figs. 1 and 2) provided with suitable laboratory equipment and psychrometric chambers as shown in Figs. 3, 4, 5, 6, 7 and 8.

Considerable controversy exists over the hypothesis that for centuries tropical countries have proved habitable for Westerners but have not proven satisfactory as a permanent living place for them and hence from the practical point of view these countries do not sufficiently satisfy their normal requirements of daily life.

In refutation it has been alleged that there are, in the tropics, settlements of Westerners, who after remaining there for several generations as a community, have retained their original outward appearance. Most of the examples cited in literature, however, have been proven on closer examination to be of little value and only one example of proof has stood criticism, involving a settlement of white people in Queensland, Australia.

However, in no particular case has it been demonstrated conclusively that the individual Westerner can remain in the tropics equally long and enjoy the same degree of fitness as in a temperate climate.

One example comprising a group of people does not give the necessary insight into the requirements of the individual. Obviously different measures of fitness for a race of people are necessary than for a single person. Certain questions overlooked in racial relations but which are of the greatest importance to the individual are personal questions such as: Do you feel comfortable? Do you feel capable of exertions which you know would be possible under favorable conditions? Even though

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*Professor in the Division for Air Hygiene of the Laboratory for Technical Hygiene at the Government Graduate School of Engineering, Bandoeng, Netherlands East Indies.

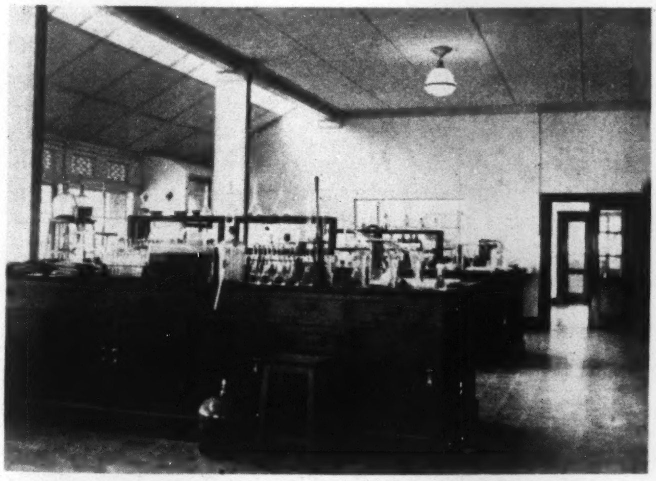

Fig. 3—View of chemical and physical work laboratory

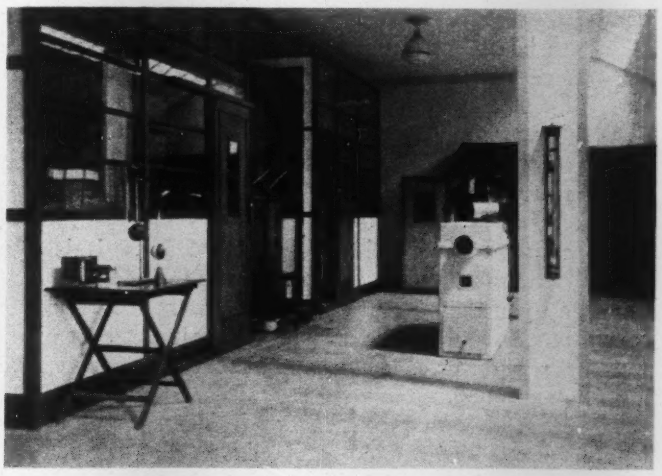

Fig. 4—Psychrometric chambers, ground floor

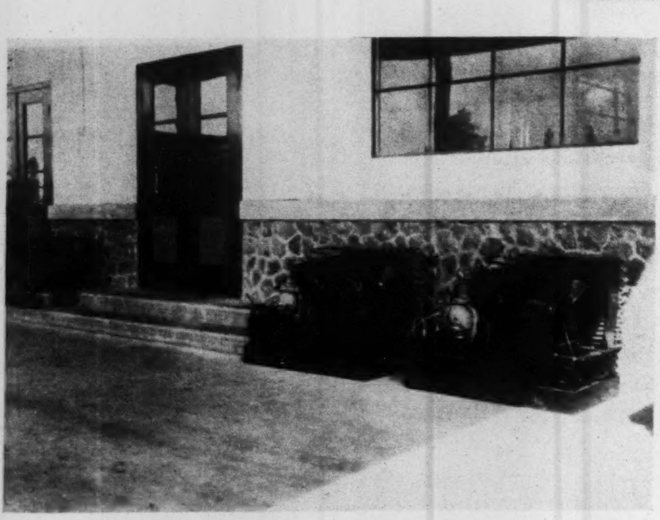

Fig. 5—Condensing unit equipment for psychrometric chambers

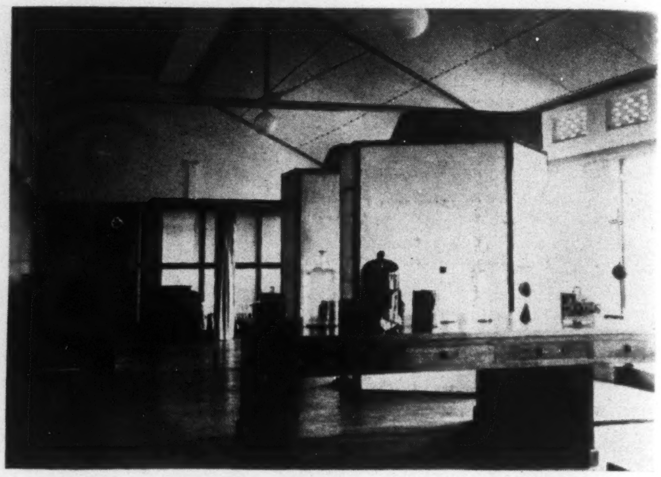

Fig. 6—General view of laboratory on second floor

the replies of many individuals should be negative the race concerned could, nevertheless, manage to thrive for centuries because there is naturally a great difference between a certain depression in the individual and the extermination of the community. Comfort is generally considered to be the first basic principle of health and thus, a very commonplace affair for the average man. Hence to thoroughly investigate the subject it is necessary to delve into the masses and observe the separate reactions of individuals and smaller groups.

Restricting this discussion to the individual in the tropics and presenting a question as to the causes of the physical and mental strain which is the almost daily experience of every inhabitant of a tropical country, the simple common-sense answer is that it is the heat. No scientific proofs are necessary for this statement as the customs and habits in the tropics bespeak sufficient conclusive language. Observation of the desire of residents of coast towns for cooler places to feel comfortable, tropical clothing, houses and holiday places, indicates one leading motive—the motive of avoiding the tropical heat, an aim ultimately carried to extreme in a periodical flight from the tropics on furlough in Europe.

Scientific data are available concerning the stress of tropical heat which shows a direct relationship between the temperature of an environment and the personal feeling of internal comfort.

Several investigators have shown irrefutably that the body temperature is dependent on the cooling capacity and that it is higher in the tropics than in more temperate air. Moreover it is widely reported that body temperature, blood circulation, metabolism, resistance to infection and working capacity are all closely inter-related. Limits of the comfort zone for this locality have been fairly accurately determined wherein the initial conditions of comfort are fulfilled in maintaining a constant body temperature of below 37 C (98.6 F). It is also recognized that there is an increase in the strain imposed upon the organism in the maintenance of proper temperature equilibrium when atmospheric conditions are far removed from the limits of the comfort zone herein mentioned.

In the Mollier diagrams shown in Figs. 9 and 10 the comfort zones determined at Bandoeng and Batavia are reproduced and give a fair illustration of conditions found in these localities. The comfort zone indicated by a heavy complete line surrounded by a dotted line applies to persons dressed in normal tropical clothes in a motionless atmosphere corresponding to an air velocity 20 cm per second (40 fpm). The dotted line is intended to indicate the transition from comfort to discomfort depending on the individual factors and, therefore, cannot be indicated by a sharp and accentuated border line.

In and around the comfort zone the circles I to V are drawn to indicate the climatic conditions for both towns. Line I represents the yearly averages of the daily air conditions; line III the limits of frequently recurring conditions; line IV the limits of rarely recurring conditions and line V the limits of extreme air conditions.

The shaded portion at the upper righthand corner of each diagram is the heat *accumulation-zone*. Under the conditions which prevail in this zone and in the surroundings where all solid objects have the same temperature as the air, the human organism cannot get rid of its excess heat. Between the comfort and heat accumulation zones lies that of discomfort. It will be noted that conditions in the Netherlands East Indies coast climate such as Batavia during the greater part of the day lie in this discomfort zone and even in the heat accumulation zone; whereas the climatic conditions in Bandoeng are practically centered around the comfort zone. However all of these data are not given herein as proofs of heat pressure but merely for information.

Based on these climatic conditions it is apparent that the social indications previously mentioned are more convincing and account for the demand for home furloughs and the migration of inhabitants to cooler climates. This fact seems to be one of the most characteristic phenomenons of the Westerners living in the tropics. Everywhere in the tropics this characteristic is to be encountered and in proportion to the intensity of heat and humidity the more frequent the furlough desire becomes. Hence home leaves become an absolute necessity even though there are Westerners who remain comparatively healthy in the tropical climate without furlough and for whom it is not a vital necessity.

Those Westerners on whom the tropical climate has little or no effect are easily recognizable. For instance there is a group of what might be termed *tropical indolents* who, while feeling the adverse effect of the climate, find it merely a welcome excuse for accomplishing only the compulsory minimum of work. They compensate for their exertion by refraining from other activities and are well satisfied with this arrangement which to them seems to be an agreeable solution.

Another group is composed of those individuals who can easily get rid of excessive body heat, whose heat-regulative mechanism works very smoothly and therefore, are not greatly disturbed in their daily accomplishments by this physical process.

A third group consists of men of the type who work by inspiration without need of previous laborious planning and who readily accomplish their projects. These people have always a reserve of productive energy available for heat regulation and as a result are little bothered by it. It seems almost a pity, however, that for people of the latter type, the history of the tropical climates was never a great success.

Along with these people is a large group of Westerners in the tropics who can get rid of their excessive body heat only by certain exertion but who are, nevertheless, eager to devote themselves entirely to their work. Such people with slow working heat regulation but still with lively intelligence, do not always find the tropics agreeable. It so happens that this group constitute by far the greater part of the Western population in this country and for these individuals the necessity of a European furlough has become an established fact. The object of such furlough is the periodical restoration of body and mind. This indicates that if considering only the functions of the body in the tropics, the Westerner undergoes slow physical deterioration; that it takes place under normal living conditions and that, at a given moment it must be corrected.

The normal course of any individual during a day is that a person works until tired and at night by rest in the form of sleep the body recuperates in order to attain once more the normal standard of vitality at the beginning of each new day. The average Westerner in the tropics appears unable to obtain this required degree of recuperation by a night's rest and it is necessary to sacrifice daily some reserve strength, so that for many the day must come when their reserves are exhausted. As a consequence the question arises, can anything be done to remedy this? One unsatisfactory solution to the problem of which few would avail themselves would be to do less work so that the necessity for regeneration of the body during rest would be proportionately less. Another form is the intensification of rest and thereby the attainment nightly of a greater degree of replenishment of strength. This latter objective may be accomplished by sleeping in a temperature that would not disturb the body by any activity for the sake of regulating the body temperature. In other words the heat-regulative mechanism of the body need not work to prevent heat accumulation.

Through extensive experimental research it has been definitely proven that in order to obtain the greatest possible amount of rest during sleep in a warm climate, and avoid the need to perspire so that the regulative temperature may remain inactive, the environmental temperature should be approximately 26 C and preferably several degrees lower. In the coast climate of Netherlands East Indies these conditions are practically never obtained in houses during the night, except by artificial cooling and hence the interest and the importance of air conditioning in the tropics. Frequently an individual's sojourn in the tropics is usually during the most vigorous period of his life when he is inclined to exert himself to the utmost and the need for conservation of body strength is such that one is surely justified in referring to the social aspects of the population. It should not, however, be concluded that air conditioned bedrooms in the tropics entirely do away with the necessity for furloughs as such a view of economy is misanthropic. Apart from the psychological value of home leave the advantage of being well in body and mind during the last years prior to going on European leave is important. Also it is desirable to be fit on furlough which is usually a time of recreation and refreshment and not, as is often the case nowadays, a means of recovery at the eleventh hour after several years of drawn out, wearisome trial.

The future of air conditioning in the tropics is of utmost importance in assuring the possibility of cool sleep and it is, therefore, this potentiality which should be developed to the greatest perfection. Considering its importance, the problem of cool sleep has the attractiveness of offering a number of satisfactory solutions. During sleep an individual is stationary for a long time and it is relatively simple to change the environment in a sleeper's immediate surroundings.

Air conditioning in operating theaters and in research

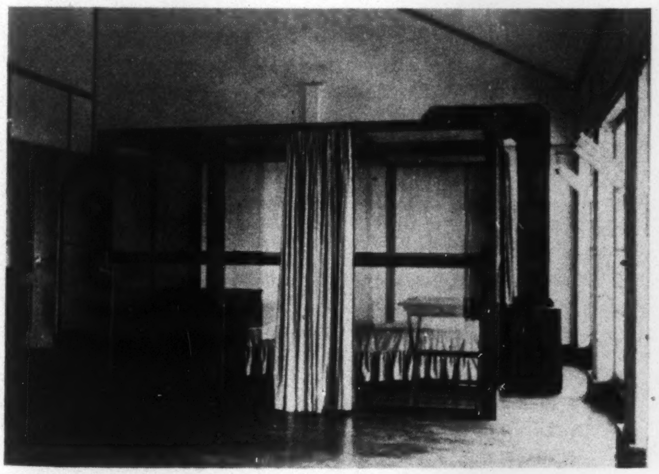

**Fig. 7—Air conditioned glass paneled bedroom cubicle**

**Fig. 8—Study and library**

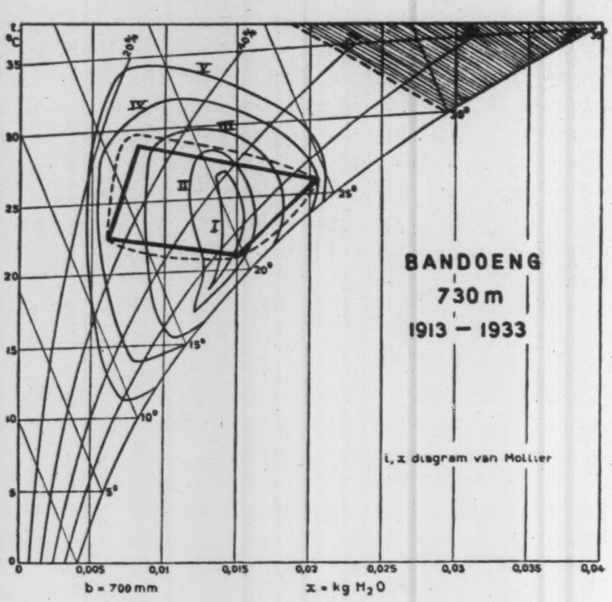

Fig. 9—Comfort and climate at Bandoeng

laboratories greatly facilitates the tasks of the workers and so furthers the ends of medical science. In the Netherlands East Indies' coast towns this can mean salvation for convalescents whose strength will not return, and above all air conditioning reduces the period of convalescence.

Air conditioning has been extensively applied in mines in order to win minerals from greater depths. In Netherlands East Indies too it has been shown that for the exploitation of deep mines it is necessary to obtain additional and more exact data on the possibilities of work in the warm, humid atmosphere of mines.

Still another aspect of the hygienic value of air conditioning in the tropics is the cooling of railway carriages. In other countries where railway carriages have already been air conditioned in the summer the public has repaid this good will of the railway companies by making abundant use of the cool carriages as a result of which the technical improvement in traveling has amply paid for itself.

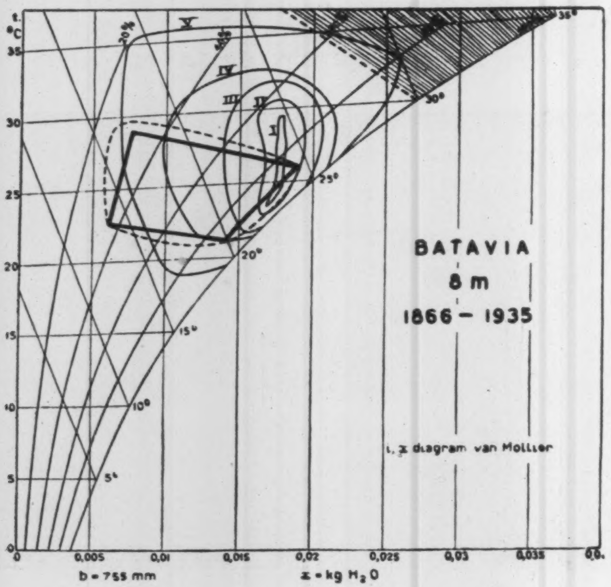

Fig. 10—Comfort and climate at Batavia

It is beyond doubt that the proposed installation of air conditioning on the Netherlands East Indian Railways will result in the same experience in this country.

In the construction of bomb-proof shelters and gas protection the study of air conditioning in this country has been able to afford fundamental guidance. Here, again, a specifically tropical element enters into the problem and the lines of work to be followed can be discovered only by research in this climate.

This outline of air conditioning research in this country serves to indicate that if the study of the improvement of tropical atmosphere is neglected an individual may be exposed to serious and preventable dangers. In many countries it is an irrefutable fact that whenever it is intended to apply new technical measures, simultaneously new reinforcements from other spheres must be introduced. The development of technical science is continuously spreading over the whole field of human endeavor and to fall behind in even a single point would be quite unsound, because to neglect science on one point is to fail all along the whole line.

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## Purdue Housing Research Supervisor Appointed

C. F. Boester, St. Louis, Mo., has been appointed housing research supervisor of the Purdue Research Foundation, according to the announcement of G. Stanley Meikle, research director, West Lafayette, Ind.

Mr. Boester has been engaged in the fields of air conditioning, refrigeration and heat transmission as a consultant and has been greatly interested in the development of low cost homes. His new activities are to initiate low cost housing research through the facilities provided by the university, the research foundation, and at the homes in community campus established several years ago.

It is planned to develop designs which will have construction and operating costs that can be readily carried by the average citizen in the lower income range.

One of the problems for immediate study deals with the requirement of housing in many areas for defense workers. It is desired to develop a low cost, fast fabricated home.

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## Strock Appointed Editor of Heating & Ventilating

On September 1 Clifford Strock became editor of *Heating & Ventilating,* and C. H. B. Hotchkiss resigned as editor of this publication to become vice-president and director of Ameresco, Inc., export representatives for heating, ventilating and air conditioning equipment.

Prior to joining *Heating & Ventilating,* Mr. Strock was with the International Heater Co., and was graduated from Purdue University, with B.S. and M.E. degrees.

At the same time Joseph F. Kern, Jr., became associate editor of *Heating & Ventilating,* and his previous experience consisted of connections with the Philross Sheet Metal Works and Erikson Equipment Co., having graduated from Brooklyn Polytechnic Institute in New York.

Both Mr. Strock and Mr. Kern are members of the American Society of Heating and Ventilating Engineers, the *American Society of Refrigerating Engineers,* and are licensed professional engineers. Mr. Hotchkiss will continue to be active with *Heating & Ventilating* in the capacity of contributing editor.

# NOMINATIONS FOR 1941

## Nominations for Officers and Council

The Nominating Committee appointed to select candidates for Officers of the Society for the coming year, 1941, submits the following list of nominees:

*For President:*
W. L. Fleisher, New York, N. Y.

*For First Vice-President:*
E. O. Eastwood, Seattle, Wash.

*For Second Vice-President:*
J. H. Walker, Detroit, Mich.

*For Treasurer:*
M. F. Blankin, Philadelphia, Pa.

*For Members of the Council:*
*Three-Year Term*

A. P. Kratz, Urbana, Ill.
W. A. Russell, Kansas City, Mo.
L. P. Saunders, Lockport, N. Y.
C. Tasker, Toronto, Ont., Canada

Respectfully submitted,
*NOMINATING COMMITTEE,*
H. H. Erickson, *Chairman*

In accordance with the provisions of the Society's Constitution, By-Laws and Rules, ballots containing the names of the above candidates will be sent to the membership for voting upon prior to the Annual Meeting in January.

*Art. B-VIII—Section* 11. The Nominating Committee shall consist of one (1) member eligible to vote designated by each Chapter, or his alternate also appointed by the Chapter. The Secretary of each Chapter shall certify to the Secretary of the Society on or before January first the names of the member and alternate selected.

The Committee shall meet at the Annual Meeting of the Society at the call of the Secretary of the Society and shall effect its own organization and elect its own Chairman. At the Semi-Annual Meeting of the Society, if possible, the Nominating Committee shall select the nominees for the ensuing year for the offices of President, First Vice-President, Second Vice-President, Treasurer, and four (4) members of the Council. In any event the names of the nominees shall be certified to the Secretary of the Society before September twentieth, with the written consent of each nominee to fill the office for which he has been selected and their names with the offices to which they have been nominated shall be published in the October issue of the Journal.

*Art. B-IX—Section* 2. The Secretary shall prepare ballots with the names of all candidates and forward them to the members, eligible to vote, at least thirty (30) days before the date of the Annual Meeting.

## Nominations for Members of Committee on Research

Although committees of the Society are usually appointed, in view of the great importance of the Committee on Research and the financial responsibility it would be called upon to assume, it has been made more representative of the entire membership of the Society by a process of *election.* The election is governed by the By-Laws for the election of officers, with the single exception that Members of the Committee on Research are nominated by the Council instead of by a Nominating Committee.

In accordance with the Regulations for the Government of the Research Laboratory, the Council announces the nomination of the following members of the Committee for election to succeed those members whose present terms expire January, 1941:

*Three-Year Term*

C. M. Ashley, Syracuse, N. Y.
M. K. Fahnestock, Urbana, Ill.
H. King McCain, Atlanta, Ga.
F. C. McIntosh, Pittsburgh, Pa.
T. H. Urdahl, Washington, D. C.

The regulations governing the nomination and election of members of the Committee on Research are as follows:

### ARTICLE II—ORGANIZATION

*Section* 1. *Committee on Research*—There shall be a standing committee known as the Committee on Research, consisting of fifteen (15) members each serving for three (3) years and five (5) retiring each year. The outgoing Chairman if serving in that capacity during the last year of his three (3) year term on the Committee shall without election become an additional member of the Committee on Research for one (1) year.

(*a*) The Council shall nominate previous to July first of each year five (5) members to fill the vacancies of those retiring at the next Annual Meeting.

(*b*) The nominations made by the Council shall be published in the October issue of the Society's Journal.

(*c*) Any ten (10) members of the Society eligible to vote may present to the Secretary over their signatures, the name of one (1) or more additional nominees for the Committee on Research, provided such name or names are presented at least sixty (60) days prior to the next Annual Meeting, and such additional nominations shall be placed on the ballot opposite the nominations made by the Council.

(*d*) The election shall otherwise conform to the regulations provided for the election of officers of the Society in the Constitution, By-Laws and Rules.

(*e*) Vacancies may be filled by the Council, such persons chosen by the Council to serve until a successor is elected at the next Annual Meeting.

# Happy Days at Houston for ASHVE Members

### October 14-15, 1940

ALL aboard! It's time for ASHVE members to start for Houston where President Giesecke and the South Texas Chapter members are awaiting to start the Fall Meeting at the Rice Hotel on October 14.

There will be two full days of enjoyment as the Committee on Arrangements has planned a balanced ration of technical talks, social and sports events which will be educational, inspirational and exciting.

At the two technical sessions five subjects will be presented and discussed. Prof. A. P. Kratz of University of Illinois will give the results of studies at the University involving the determination of the air velocities and temperatures existing at various points in a representative room, as affected by the location of the supply and exhaust openings, the temperature and velocity of the air at the supply openings, and the temperature outside of the exposed walls of the room. W. G. Darley, Cleveland, Ohio, will present data on the need for better lighting, explaining how in properly-designed direct and direct-indirect fluorescent lighting systems the brightnesses in the normal line of vision can be maintained at a relatively low value and, furthermore, the light is of a cooler color; thus the psychological heating effect is reduced. F. R. Bichowsky, Ann Arbor, Mich., in presenting his paper on chemical dehumidification agents will give a comparison of various solid absorbents showing amount of water absorbed at varying relative humidities. He will show that a great number of combination solutions where dehydration may be used is possible by combining dehydration with evaporative cooling, with refrigeration and with solvent recovery. A. J. Rummel, San Antonio, Tex., will discuss direct evaporative cooling for homes in the Southwest, giving an analysis of climatic conditions and presenting a comfort chart which covers conditions that prevail in the Southwest. In his summary he will describe a test house installation, giving the results of numerous investigations of varying conditions of air supply and air change.

Houston Ship Channel

Houston Museum of Fine Art

A study of Texas weather conditions and their effect on human comfort will be the subject of a talk by Prof. Howard E. Degler, chairman of the Department of Mechanical Engineering, University of Texas.

F. C. Houghten, director of the ASHVE Research Laboratory, Pittsburgh, will speak on "Our Present and Future Research Program." He will give data on some of the recent investigations, such as comfort at low humidities, and will outline some of the future investigations which will be undertaken at the Pittsburgh Laboratory and in cooperating institutions.

There will be a get-together luncheon on Monday at noon, in the afternoon the Council will meet and there will be golf for those who want to play as well as a sightseeing trip to Rice Institute, San Jacinto Battle Ground, and Sylvan Beach.

On Monday evening, at the Banquet, John T. Scott, chairman of the board of the First National Bank of Houston, will act as toastmaster, according to the announcement of A. M. Chase, Jr., chairman of the Banquet Committee. Music and dancing will follow.

Tuesday morning there will be a technical session and in the afternoon inspection trips will be featured.

There is much to do and see in Houston. It is the center of many industrial processes and for many years has been termed the oil capital of the world, because so much of the nation's oil production and refining is concentrated within a few miles of the city. The oil production of the 185 fields which lie within 150 miles of the city average over 300,000 barrels of oil per day. Houston is also known as the only city to which all nations send their ships and it is the world's greatest cotton port.

Houston has two major universities, Rice Institute and the University of Houston, which has day and night courses, and it is the only college in the country that has completely air cooled and air conditioned buildings.

President Rummel extends a cordial invitation to visit the great Southwest and enjoy the hospitality of the South. Chairman McKinney says "Come early, we're all ready with an exciting football game Saturday night and a special motor trip to Galveston on the Gulf Sunday morning."

It's cotton-country's turn to entertain
and you're invited—
To join the crowd in Houston where
we're sure you'll be delighted—
With a program that is different and
with sights that will be new—
May we greet you all in Texas
with a hearty Howdy-do?

## Fall Meeting Program

### Rice Hotel—Houston, Texas

### October 14-15, 1940

*October 12*

1:00 p.m. Reception of Members by Houston Chapter Committee

8:15 p.m. Football Game, Rice Stadium (Rice vs. L.S.U.—Tickets $2.50 per person)

*October 13*

10:00 a.m. Golf—Brae Burn Country Club (Greens Fee $2.00 per person)

2:00 p.m. Bayshore Drive and Visit to Galveston

*October 14*

8:30 a.m. Registration (Mezzanine Floor)

10:00 a.m. Technical Session—

- Development of Instruments for the Study of Air Distribution in Rooms, by A. P. Kratz, A. E. Hershey and R. B. Engdahl.
- Cooler Footcandles for Air Conditioning by W. G. Darley
- Chemical Dehumidification Agents, by F. R. Bichowsky

12:15 p.m. Get-together Luncheon—($1.00 per person)

1:45 p.m. Sightseeing Trip (register in advance, tickets $1.00)—City trip to Rice Institute, Battle Ground, Sylvan Beach.

1:45 p.m. Informal Golf Matches

2:00 p.m. Council Meeting

4:30 p.m. Friendship Hour for Members and Ladies

7:00 p.m. Informal Banquet and Dance (tickets $2.50 per person)

*October 15*

9:00 a.m. Registration

10:00 a.m. Technical Session—

- Weather Conditions in Texas vs. Human Comfort, by H. E. Degler.
- Our Present and Future Research Program, by F. C. Houghten
- Direct Evaporative Cooling for Homes in the Southwest, by A. J. Rummel

10:45 a.m. Ladies Breakfast Bridge and Style Show

12:00 p.m. Junior Chamber of Commerce Luncheon—Speaker Stanley Foran. Subject: Americanism—Let's Resell It to the World

2:00 p.m. Inspection Trips

**The Rice Hotel**

### Committee on Arrangements

*General Chairman*—C. A. McKinney.

*Assistant General Chairman*—J. van O. Weaver.

*Publicity Committee*—J. A. Walsh, *Chairman;* H. J. Martyn.

*Transportation Committee*—W. R. Etié, *Chairman;* F. A. Rodgers.

*Tours Committee*—I. A. Naman, *Chairman;* W. L. Barnes, S. H. Green, R. J. Salinger.

*Banquet Committee*—A. M. Chase, Jr., *Chairman;* R. E, Tucker, G. R. Rhine, B. J. Beaird, M. L. Brown.

*Registration Committee*—D. S. Cooper, *Chairman;* J. A. Bishop.

*Entertainment Committee*—A. B. Banowsky, *Chairman;* R. M. Spencer, I. E. Rowe, C. R. Gardner.

*Finance Committee*—R. F. Taylor, *Chairman;* R. J. Salinger, R. K. Werner.

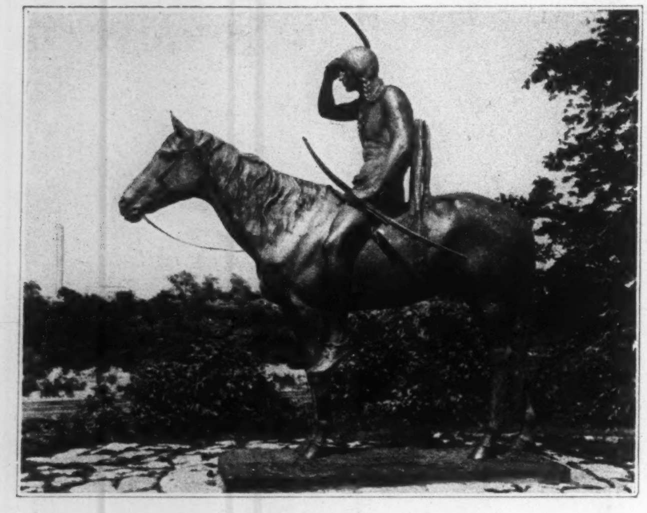
*Ladies Committee*—A. F. Barnes, *Chairman;* J. D. Morrow, R. M. Spencer, L. C. McClanahan.

*Sports Committee*—G. D. Maves, *Chairman;* R. W. Kurtz, R. G. Lyford.

**A. J. Rummel, *President***
**South Texas Chapter**

**C. A. McKinney,**
***General Chairman***
**Committee on Arrangements**

**D. S. Cooper, *Vice-President***
**South Texas Chapter**



Statue of the Indian Scout

# Kansas City for 47th Annual Meeting January 27-29

Petticoat Lane—The Shopping Center

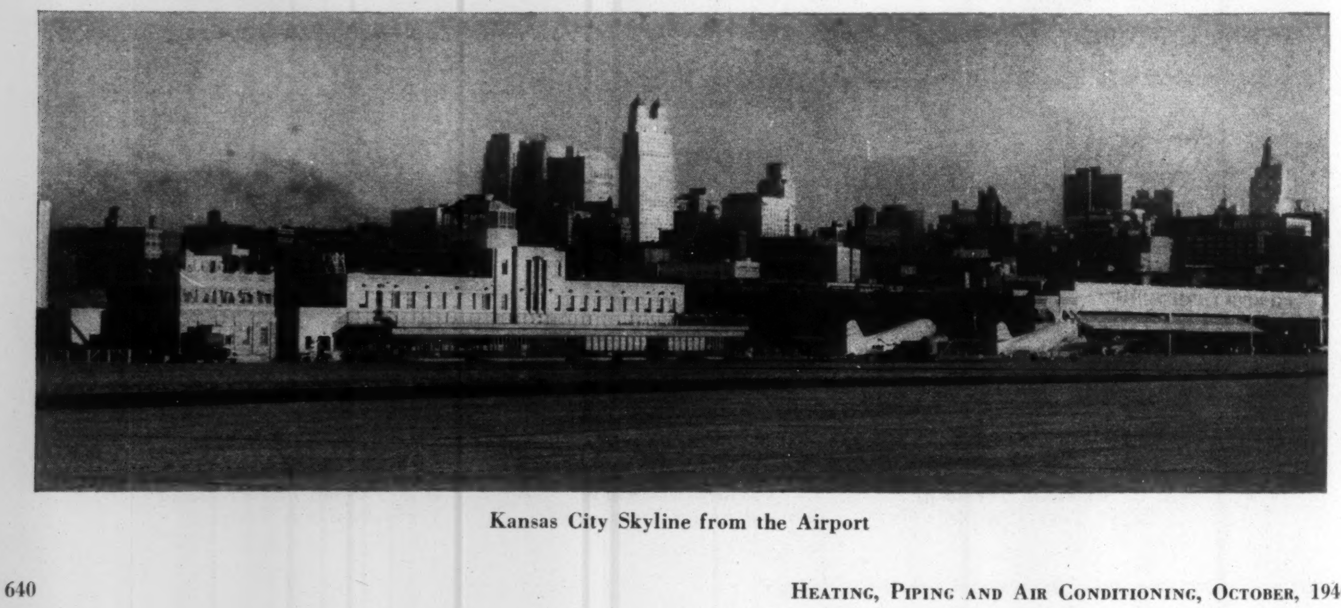
Kansas City Chapter is making early preparations for the entertainment of the Society at the 47th Annual Meeting, January 27-29, 1941.

The Committee on Arrangements has planned events for the three-day meeting and has selected Hotel Muehlebach as meeting headquarters.

Pres. W. L. Cassell of Kansas City Chapter extends a cordial invitation to visit The Heart of America, to exchange ideas, to renew old friendships and to make new friends. So don't miss the 47th Annual Meeting.

The committee in charge of events to make the members' visit enjoyable and memorable is: John M. Arthur, Jr., general chairman; Wm. L. Cassell, co-chairman; A. D. Marston, vice chairman; Henry Nottberg, Jr., N. W. Downes, L. A. Stephenson, Edward M. Jolley, Forrest F. Dodds, Henry Gould, E. Kirker Campbell, Jr., Mrs. William A. Russell, and F. A. Sheppard.

The Jackson County Court House



Kansas City Skyline from the Airport

## Minnesota Holds First Meeting of Season

*September 9, 1940.* The September Meeting of the Minnesota Chapter of the Society was held at the Minneapolis Y.M.C.A. Pres. M. H. Bjerken called the meeting to order, and the minutes of the May meeting were read and approved. A report on the special August meeting at Rochester was given and N. D. Adams, who was in charge of arrangements at Rochester, was praised for his efforts and for the activities planned.

Due to conflict of other meetings with the regular meeting night of the Minnesota Chapter, which has been the second Monday of the month, a motion was made, properly seconded and passed, that the meeting night be changed to the first Monday.

President Bjerken introduced the speaker, Dr. W. F. Holman, supervising engineer of buildings and grounds, University of Minnesota, who discussed the buildings recently completed on the campus, the Men's and Women's dormitories, Natural History Museum, Journalism Building, and the Men's Union.

Dr. Holman gave a very interesting description of the mechanical equipment, and at the close of his talk a rising vote of thanks was extended him.

N. D. Adams extended the Chapter's appreciation to William McNamara, chairman of the membership committee, for his efforts in obtaining new members. Mr. Adams also mentioned the Society's forthcoming meeting at Houston and urged all who could to attend. The meeting was adjourned at 8:30 p.m., according to the report of the secretary, D. B. Anderson.

## Kansas City Officers and Committees

The Kansas City Chapter reports 66 members on its rolls and the following officers and personnel of existing committees:

*President*—W. L. Cassell
*Vice-President*—Gustav Nottberg
*Secretary*—E. M. Jolley
*Treasurer*—E. K. Campbell, Jr.
*Board of Governors*—A. D. Marston, F. F. Dodds and N. W. Downes.
*Membership*—Carl Clegg, chairman; D. D. Zink and E. K. Campbell.
*Attendance*—W. L. Cassell, chairman; Gustav Nottberg, E. M. Jolley, E. K. Campbell, Jr., A. D. Marston, F. F. Dodds and N. W. Downes.
*Entertainment and Speakers*—Gustav Nottberg, chairman; K. M. Stevens, F. J. Dean, Jr., D. D. Zink and Henry Nottberg, Jr.
*Building Code*—N. W. Downes, chairman.

## Oklahoma Chapter Officers

The newly elected officers and committees of the Oklahoma Chapter are as follows:

*President*—S. L. Rolland
*Vice-President*—C. R. Kidd
*Secretary-Treasurer*—A. R. Morin
*Board of Governors*—R. E. Pauling and Earle W. Gray.
*Membership*—Earle W. Gray, chairman; E. F. Dawson and A. R. Morin.
*Standards and Codes*—S. L. Rolland, chairman; R. G. Dolan and F. X. Loeffler.
*Meetings*—J. M. Mideke, Earle W. Gray and E. F. Dawson.
*Research Representative*—J. H. Carnahan.

The secretary of the chapter reports a total of 20 members on its rolls as the season opens.

## New Officers for Manitoba

The officers to serve the Manitoba Chapter were announced recently as follows:

*President*—P. L. Charles
*Vice-President*—R. L. Kent
*Secretary-Treasurer*—Ivan McDonald
*Board of Governors*—P. L. Charles, F. L. Chester, G. C. Davis, R. L. Kent, Ivan McDonald and E. F. Munn.

The various committee chairmen are as follows: *Membership*—Frank Thompson; *Research* and *Publicity*—J. B. Steele; *Program* and *Speakers*—D. F. Michie; *Attendance*—William Worton.

## Fall Meetings for Pacific Northwest Announced

At the October 1 meeting of the Pacific Northwest Chapter an interesting discussion on combustion, illustrated with slides, was given. The meeting scheduled for November 5 will have Prof. F. K. Kirsten, who will discuss the operation and principles of a centrifugal filter, of which he is the inventor. Walter Leek, Vancouver, B. C., Life Member of the ASHVE, will be the guest speaker at the meeting arranged for December 3, and he will discuss the evolution and history of heating and plumbing.

The chapter announces that there are 28 members now on the rolls, and the officers and committee personnel are as follows:

*President*—M. J. Hauan
*Vice-President*—F. J. Pratt
*Secretary*—H. T. Griffith
*Treasurer*—R. E. Chase
*Board of Governors*—W. W. Cox, C. W. May and R. O. Wesley.
*Program*—S. D. Peterson and M. J. Hauan.
*Membership*—W. W. Cox and R. D. Morse.
*Seattle Heating Code Committee*—M. J. Hauan, C. W. May, J. J. Ward and B. M. Veltman.

## Illinois Announces Fall Program

The October meeting of the Illinois Chapter will be a meeting on national defense, particularly as the plant construction program affects heating, ventilating and air conditioning. It is expected that one of the speakers will be an army procurement officer, and someone of authority on heating, ventilating and air conditioning who has had experience in defense work will be the second speaker.

An *information please* sort of a meeting is scheduled for November, with questions submitted in advance by members as the basis, and any questions from the floor which may come up during the discussion. I. E. Brooke has consented to be the *interlocutor* who will have a panel of three or four experts from the chapter membership.

The December meeting has been tentatively scheduled as a joint meeting with the local *ASRE*, and it is expected that Dr. Poulter, Armour Research Foundation, will speak on his further antarctic experiences and the performance of the snow cruiser.

It is planned to have the papers presented at the Society's Annual Meeting in Kansas City discussed at the January meeting.

At the annual meeting of the Illinois Chapter, held in May, the following officers were elected and duly installed:

*President*—V. L. Sherman
*Vice-President*—I. E. Brooke
*Treasurer*—E. M. Mittendorff
*Secretary*—M. W. Bishop
*Board of Governors*—A. O. May, W. A. Kuechenberg, L. J. Pitcher and Tom Brown.

The following committees have been appointed by President Sherman for the 1940-41 season:

*Membership*—A. O. May, chairman; H. C. Gotschall, J. S. Kearney, J. J. Philippi and L. J. Pitcher.
*Finance*—E. M. Mittendorff, chairman; C. E. Crone, H. J. Prebensen and N. W. Swanson.
*Meetings and Publications*—C. M. Burnam, Jr., chairman; I. E. Brooke, H. C. Mueller, K. C. Porter and Lester Seelig.
*Legislative*—J. J. Hayes, chairman (1941); S. I. Rottmayer and J. R. Vernon.
*Special Committee*—W. A. Kuechenberg, chairman; R. E. Hattis, John Howatt and S. R. Lewis.

## Delta Chapter Announces Officers and Committees

In reporting the progress of the Delta Chapter it was announced that the following will serve for the coming season:

*President*—G. E. May
*Vice-President*—C. B. Gamble
*Treasurer*—G. C. Kerr
*Secretary*—F. G. Burns.
*Board of Governors*—F. G. Burns, G. C. Kerr, C. B. Gamble and G. E. May.

The personnel of the committees to serve with the preceding officers is as follows:

*Constitution and By-Laws*—L. S. Weil, chairman; R. J. Holzer, Jr., A. L. Dunlap and Ralph Elizardi.
*Membership*—J. J. Friedler, Jr., chairman; L. V. Cressy, G. A. Hero, Jr. and I. H. Purinton.
*Program*—John Devlin, chairman; J. O. Crary, O. E. Gammill, Jr. and L. K. Nelson.

According to the report from the secretary there are 41 members now on the rolls of the Delta Chapter.

## Iowa Chapter Elects Officers

In preparing for the Fall season the Iowa Chapter, with 37 members on its rolls, announces the following newly elected officers and committees:

*President*—R. A. Norman

*Vice-President*—Perry La Rue

*Secretary-Treasurer*—N. B. Delavan

*Board of Governors*—B. E. Landes, M. L. Todd and T. R. Johnson.

*Meetings*—Perry La Rue, chairman; W. W. Stuart, J. C. Knox, J. F. Sandfort and J. M. Friedline.

*Membership*—F. E. Triggs, chairman; L. E. Hedeen, J. E. Tone, Jr., R. M. Herbert and A. H. Raven.

*Finance*—C. W. Helstrom, chairman; M. T. Johnston and R. F. Winterbottom.

*Legislative*—M. L. Todd, chairman; E. H. Borg, W. V. Hagan and Bowen Campbell.

*By-Laws*—T. R. Johnson, chairman; A. L. Walters and D. C. Murphy.

*Nominating*—A. L. Walters, chairman; E. H. Danielson, and Maurice Olchoff.

## Pittsburgh

The Pittsburgh Chapter reports a total of 65 members on its rolls at the opening of the Fall season. The officers and committees serving at the present time are as follows:

*President*—F. C. McIntosh

*Vice-President*—E. C. Smyers

*Treasurer*—L. S. Maehling

*Secretary*—T. F. Rockwell

*Board of Governors*—R. A. Miller, R. J. J. Tennant and G. G. Waters.

*Advisory*—M. L. Carr, P. A. Edwards, R. B. Stanger, J. F. Collins, Jr., F. C. Houghten, C. M. Humphreys and A. F. Nass.

*Program*—H. B. Steggall, General Chairman; G. O. Weddell, P. C. Strauch, J. E. McLean and C. E. Parks.

*Attendance*—F. B. Mahon, chairman; *Greeting*—E. H. Riesmeyer, Jr., chairman; *Membership*—B. R. Small, chairman; *Finance*—H. A. Beighel, chairman.

It is planned to have Dr. F. E. Giesecke, president of the ASHVE, as the guest at the November 18 meeting. The December 9 meeting will be the annual business meeting.

## CANDIDATES FOR MEMBERSHIP

**The Constitution of the Society, as now amended, requires the following mode of procedure in voting on applicants for membership in the Society. All applications for membership are to be sent to the Secretary and the names of applicants and their references shall be printed in the next issue of the JOURNAL of the Society or sent to the members in other approved manner as ordered by the Council. When replies are received from references, the Candidate's application shall be submitted to and acted upon by the Committee on Admission and Advancement as soon as possible.**

**When the Committee on Admission and Advancement has acted favorably upon a Candidate's application and assigned his grade, the Council shall vote upon the election of the proposed Candidate for membership by letter ballot. During the past month** 6 applications for membership have been received and the names of these men and their sponsors are published in the following list.

**Members are requested to scrutinize the list with care. The Committee on Admission and Advancement, and in turn, the Council, urge the members to assume their share of responsibility of receiving these candidates into membership by advising the Secretary promptly of any whose eligibility for membership is in any way questioned.**

**All correspondence in regard to such matters is strictly confidential, and is solely for the good of the Society, which it is the duty of every member to promote.**

Unless objection is made by some member by October 15, 1940, these candidates will be balloted upon by the Council. **Those elected to membership will be notified by the Secretary immediately after election.**

| CANDIDATES | REFERENCES<br>*Proposers* | *Seconders* |
|---|---|---|
| EAST, R. G., Asst. to Sr. Designing Engr., Matthew Hall Co., Ltd., London, N.W.1, England. | A. C. F. Mackadam (*Non-Member*)<br>Dr. Charles Porter, M.D. (*Non-Member*) | S. H. Burroughes (*Non-Member*)<br>G. A. Rooley (*Non-Member*) |
| GILBERT, THOMAS, Salesman, Empire Brass Mfg. Co., Ltd., London, Ontario, Canada. | F. E. Ellis<br>L. L. Anthes | O. L. Robb (*Non-Member*)<br>G. M. Morran (*Non-Member*) |
| JALONACK, IRWIN G., Chief Engr., Alfred L. Hart, Inc., Jamaica, N. Y. (*Advancement.*) | A. N. Volkhardt<br>D. W. McLenegan | J. LaRaus (*Non-Member*)<br>D. J. Slack (*Non-Member*) |
| MCCLOSKEY, JOHN H., Plbg. and Htg. Contr., Elkton, Md. | M. F. Blankin<br>C. Fred Dietz | H. H. Erickson<br>A. E. Kriebel |
| PETERSEN, BRUCE W., Engr., Twin City Furnace Co., Minneapolis, Minn. | H. M. Betts<br>H. C. Mills | J. C. Davidson<br>C. O. Carlson |
| WRIGHT, JOHN B., Sales Engr., Nash Engineering Co., South Norwalk, Conn. | I. C. Jennings<br>E. A. Mead | H. E. Adams<br>C. J. Lyons |

## CANDIDATES ELECTED

In the past issues of the JOURNAL of the Society the names of the following men were listed as Candidates for Membership. The membership grade of each Candidate has been assigned by the Committee on Admission and Advancement and balloted upon by the Council. We are now instructed by the Council to post herewith, as required by Art. B-III, Sec. 8, of the By-Laws, the following list of candidates elected:

### MEMBERS

HANNIGAN, WILLIAM, Building Superintendent, Acacia Mutual Life Insurance Co., Washington, D. C.

PFEIFFER, DAVID C., Power Sales Engr., Dallas Power & Light Co., Dallas, Tex.

### ASSOCIATES

AKERS, ARTHUR W., Director, Technicians Institute, New York, N. Y.

CONNORS, EDWARD C., Engr. Custodian, Chicago Board of Education, Chicago, Ill.

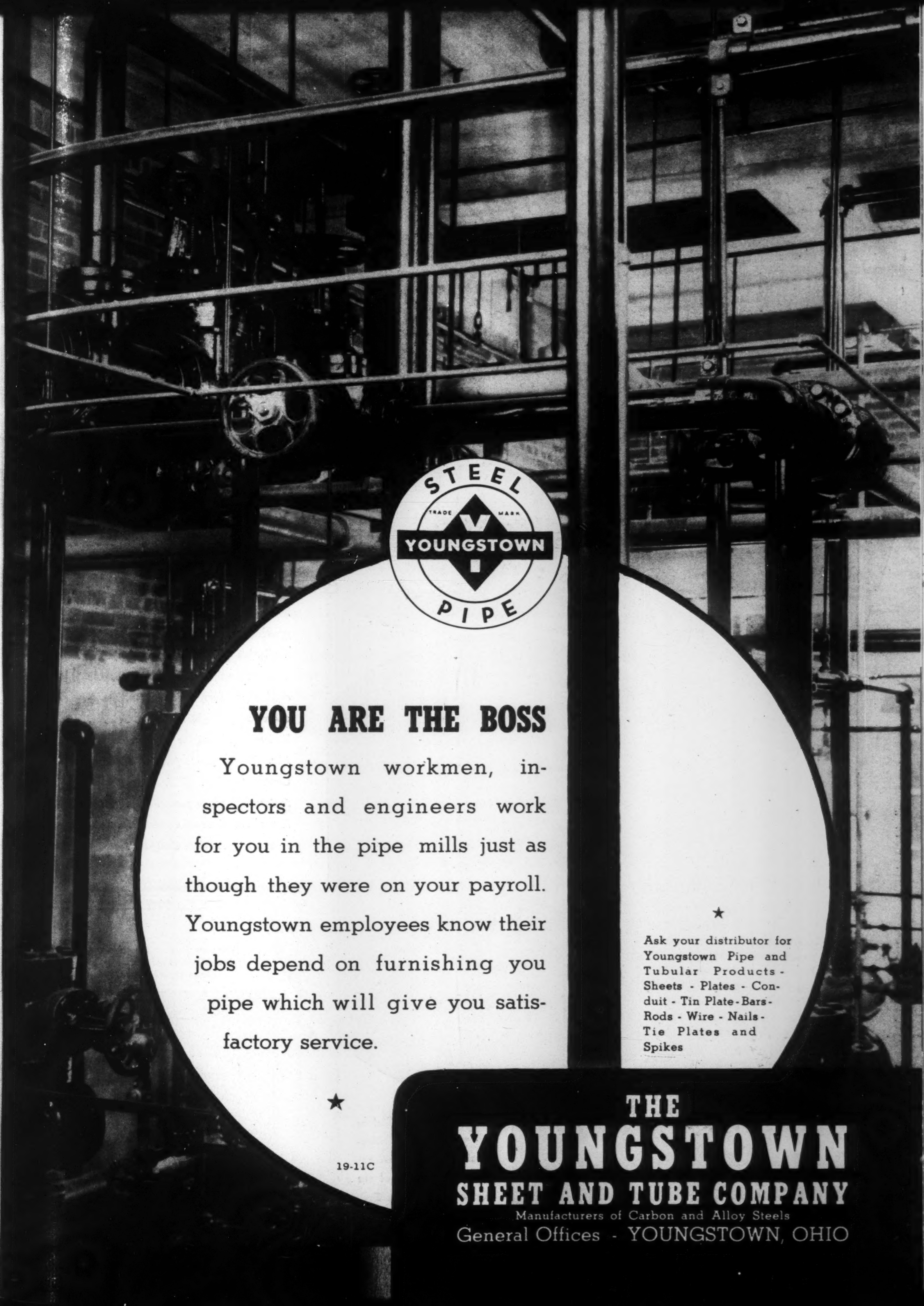
MARKERT, JOHN W., Assoc. Naval Architect, U. S. Maritime Commission, Washington, D. C.

SUTCH, HARRY C., Htg. Engr., Montgomery Ward, Chicago, Ill.

WALLIS, WALTER M., Htg. Contr., Seattle, Washington.

### JUNIORS

LEVINE, LAWRENCE J., Asst. Engr., Paragon Oil Burner Corp., Brooklyn, N. Y.



STEEL
TRADE MARK
YOUNGSTOWN
PIPE

## YOU ARE THE BOSS

Youngstown workmen, inspectors and engineers work for you in the pipe mills just as though they were on your payroll. Youngstown employees know their jobs depend on furnishing you pipe which will give you satisfactory service.

★

Ask your distributor for Youngstown Pipe and Tubular Products - Sheets - Plates - Conduit - Tin Plate - Bars - Rods - Wire - Nails - Tie Plates and Spikes

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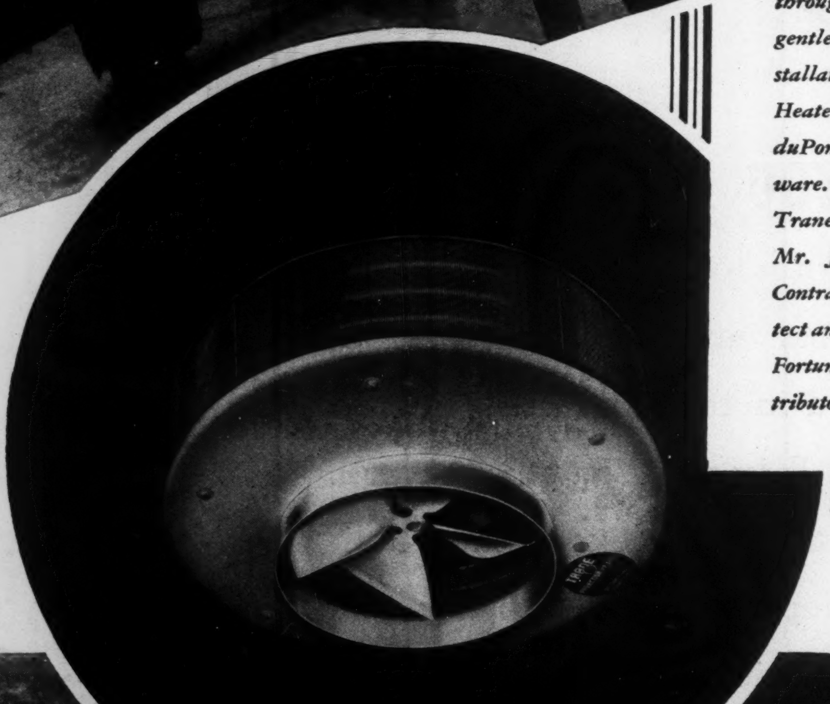
19-11C

THE
YOUNGSTOWN
SHEET AND TUBE COMPANY
Manufacturers of Carbon and Alloy Steels
General Offices - YOUNGSTOWN, OHIO

# VITAL INDUSTRIES *Select* TRANE

*Another heating problem solved through teamwork. Here are the gentlemen who cooperated on the installation of Trane Projection Unit Heaters in the new hangar at the duPont Airport, Wilmington, Delaware. Left to right: Mr. A. A. Granke, Trane Wilmington representative; Mr. Joseph J. Rapuano, Heating Contractor; Mr. H. S. Stees, Architect and Engineer; and Mr. Agostino Fortunato, General Contractor. Distributor: Speakman Company.*

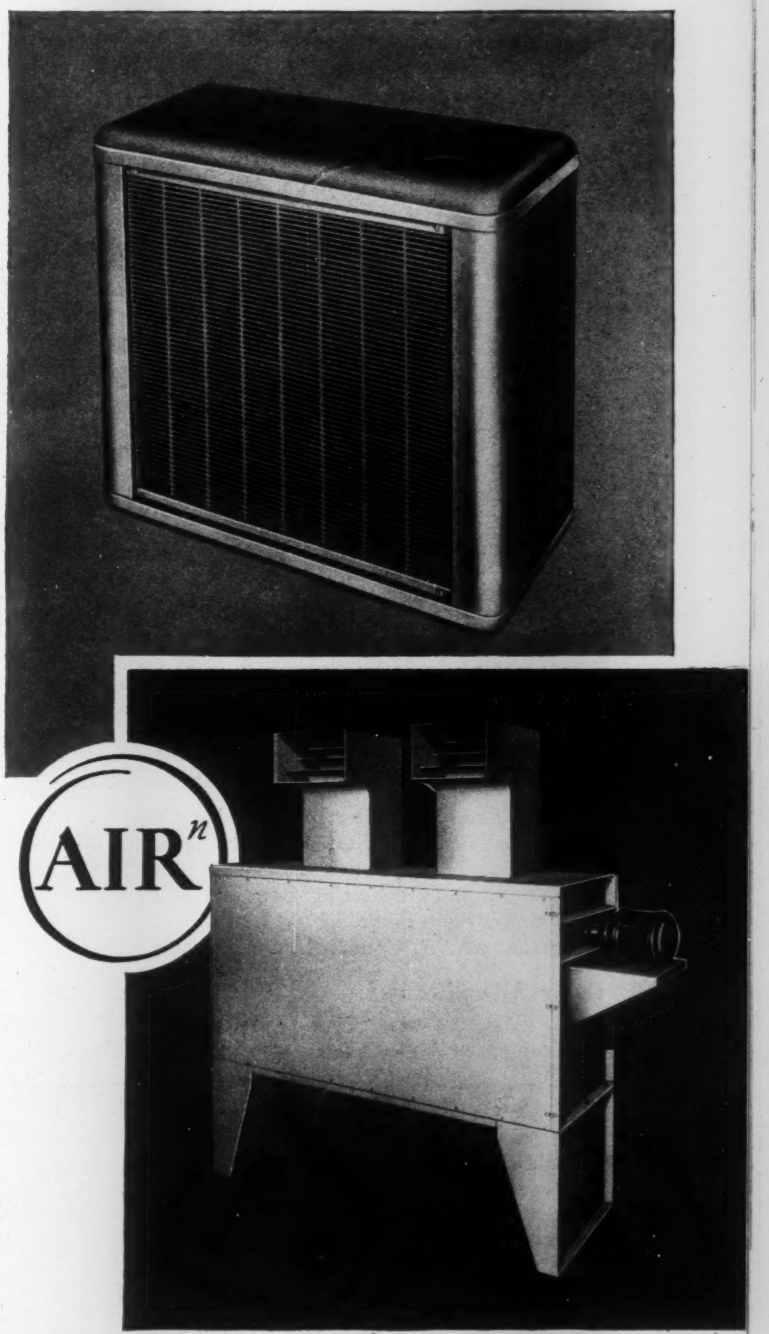


New Plant of Pratt & Whitney,
Division Niles-Bement-Pond
Company, West Hartford, Conn.

The new Boeing Stratoliner
... built in plant heated by
Trane Unit Heaters.

Thousands of installations in a wide variety of commercial and industrial applications have proved the superiority of Trane Projection Unit Heaters.

# UNIT HEATERS



*Practical demonstration*
*of* **TRANE** *slogan*

## "TEAMWORK *with* ARCHITECTS ENGINEERS • CONTRACTORS"

NATIONAL defense, fast delivery, and plant expansion go hand in hand. That's why they have found such an ideal running mate in Trane Unit Heaters—the ideal Unit Heaters for all industrial heating requirements. Trane has fifty-five years of experience and knowledge in correct heating for your benefit. Trane pioneered and introduced the only advancement in unit heating in over a decade—the Trane Projection Heater. This is the Unit Heater which the nation's leading architects, engineers, contractors, and industrials have recognized as the correct solution to many heating problems.

Nationwide coverage! Trane has a nationwide coverage of eighty-five offices staffed by competent men trained to collaborate with trade and profession and to give nationwide, on-the-spot service—the same service given the Austin Company, general contractors, and W. E. Beggs, heating contractor, for the Boeing Aircraft Company at Seattle—the same service given Albert Kahn, Inc., architect and engineer, and the Donald Miller Company, contractors, for Pratt & Whitney at West Hartford, Connecticut.

Trane recognizes fast delivery as the watchword of the hour. Vital firms like Boeing Aircraft and Wright-Aeronautical have found it expedient and profitable to select Trane Unit Heaters for their new plants. And remember—Trane manufactures the most complete line of heating, cooling, and air conditioning equipment commercially available—for comfort and process.

Unbiased recommendations from Trane. There is a size and model and type of Trane Unit Heater to meet your every requirement. Trane manufactures Propeller type and Blower type Unit Heaters as well as the Trane Projection Unit Heater.

**TRANE**

AIR^n

**THE TRANE COMPANY LA CROSSE, WISCONSIN**

*Also* **TRANE COMPANY OF CANADA LTD., TORONTO, ONTARIO**
*Heating... Cooling... Air Conditioning Equipment from 85 Offices*

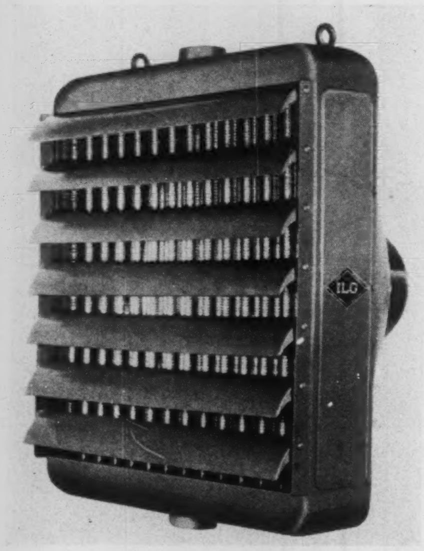
**Unit Heaters - Specialties - Convectors - Cooling Coils - Blast Coils - Unit Ventilators - Compressors - Air Conditioners - Low Pressure Refrigeration**

# *Equipment* DEVELOPMENTS

**For your convenience in obtaining more information about any of this equipment, see coupon on this page. Add the new products and companies listed here to your Directory Section which you received in your January, 1940, Heating, Piping and Air Conditioning and thus keep your records of sources of supply up to date throughout the year . . . Single asterisk (*) indicates equipment not listed in Directory Section; double asterisk (**) equipment and manufacturer not listed**

## Unit Heaters

No. 1949—Most important feature of the new line of "Vital Zone" steam unit heaters is the fully enclosed, self-cooled motor that "breathes," says the manufacturer. The second feature is the two piece header designed to give balanced steam distribution and to permit each tube to expand and contract uniformly.



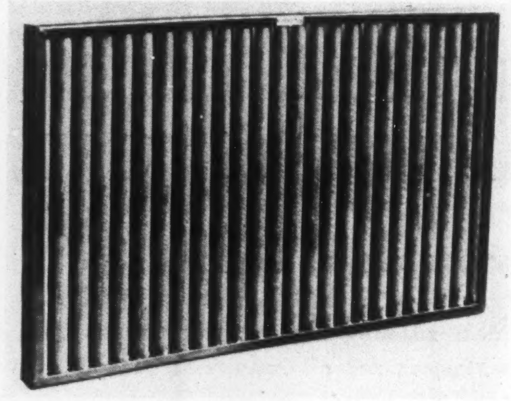
The heating coil is made entirely of copper, with 26 ga fins flanged and pressed on ½ in. OD seamless tubes. Brass orifice bushings expand the tubes uniformly in the header plates. At the bottom, the header floats on slotted coil retainer and spring washers to allow for expansion and contraction of the coil independent of the unit casing.

With individually adjusted louvers to lessen air turbulence and increase heating range, these units "shoot" the heated air from 40 to 80 ft, delivering from 385 to 6900 cfm, depending upon size of unit, according to the maker.—Ilg Electric Ventilating Co., 2850 N. Crawford Ave., Chicago, Ill.

## Odor Adsorbers

No. 1950—The new "Type G Dorex" adsorber panels for air conditioning and ventilation systems consist of metal frames housing a battery of exposed perforated metal tubes which contain activated granular coconut shell carbon. They are available in stock sizes suitable for installation in air ducts, attachment to standard dust filters and for outlet and inlet grilles.

According to the manufacturer, these odor adsorbers allow recirculation of a greater volume of conditioned air and less outside air need be introduced for odor dilution. In this way thermal load on the air conditioning system is reduced.



The units are adaptable to either existing or new installations.—W. B. Connor Engineering Corp., Dorex Air Conditioning Div., 114 E. 32nd St., New York, N. Y.

**FOR YOUR CONVENIENCE**

Heating, Piping and Air Conditioning, [10-40]
6 N. Michigan Ave., Chicago, Ill.

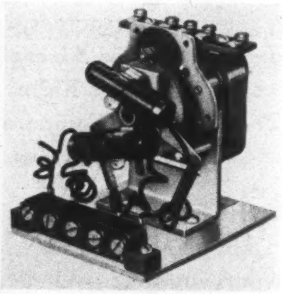
Please ask the manufacturers to send me more information about the equipment mentioned under the following reference numbers in "Equipment Developments" and "Recent Trade Literature." (Circle each number in which you are interested):

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1949 | 1950 | 1951 | 1952 | 1953 | 1954 | 1955 | 1956 | 1957 | 1958 |
| 1959 | 1960 | 1961 | 1962 | 1963 | 1964 | 1965 | 1966 | 1967 | 1968 |
| 1969 | 1970 | 1971 | 1972 | 1973 | 1974 | 1975 | 1976 | 1977 | 1978 |
| 1979 | | | | | | | | | |
| 3656 | 3657 | 3658 | 3659 | 3660 | 3661 | 3662 | 3663 | 3664 | 3665 |
| 3666 | 3667 | 3668 | 3669 | 3670 | 3671 | 3672 | 3673 | 3674 | 3675 |
| 3676 | 3677 | 3678 | 3679 | 3680 | 3681 | 3682 | 3683 | | |

Name ........................................Title..........
Company ..............................................
Address ...............................................
City ........................................State...........

## Motor Relay

No. 1951—The new "Motorelay" illustrated consists of a small reversible, geared head, shaded pole "Barcol" motor which tilts two mercury tubes. The tubes are arranged to give single pole, double throw operation, with spring return to a neutral off position.



The device permits throttling, floating or proportioning control of a 5 amp load from a sensitive instrument having a current rating as low as 0.35 ampere. Chattering is eliminated, the maker states, because a momentary contact at the instrument does not sufficiently close the mercury tube switch.

This relay is particularly suited to floating or proportioning control of line voltage motors operating large dampers, valves, speed adjusters, voltage regulators, etc.—Barber-Colman Co., 225 Loomis St., Rockford, Ill.

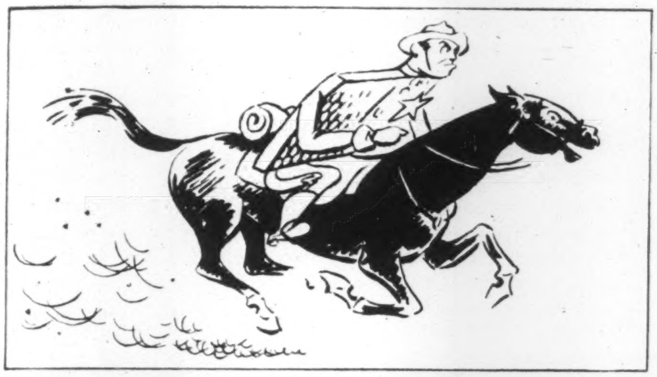
## Housing Material for Conditioners

No. 1952—A new type of steel material for housing factory built units and other air conditioning equipment is known as

# Brother, this picture-page can save you money!

**1 The treasurer** can never put you in a sweat because of high filter costs. Dust-Stops* cost approximately 1-cent per CFM to install, including frames; approximately 1/10th-cent per CFM when filters need changing. A big saving over many other types of installations.

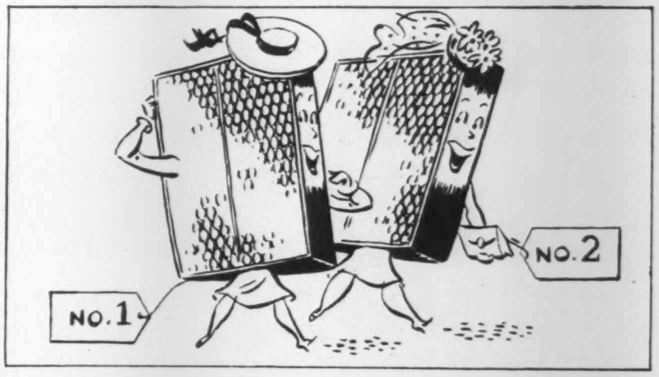
**2 Let the plant** firemen gather cobwebs, as far as Dust-Stops are concerned. Remember this *always*—Dust-Stops are safer, because the all-glass filtering medium, Fiberglas* fibers, and the patented adhesive will not support combustion.



**3 Like the Northwest** Mounties, Dust-Stops get what they go after. They arrest virtually all "nuisance" dusts. Capacity: 2 CFM per square inch of filter area at 300 FPM. Resistance (in inches of water gauge per inch of depth): .045 to .050 clean, and .11 to .12 dirty.

**4 And the president** can't get you out on a limb because the installation bleeds. The dust-catching adhesive on these filters will not deposit tiny droplets in the ducts or on the walls. And the fire-hazard from oil in the duct system is nil.

**5 How much skilled** labor is required to change socks? That's how easy it is to change Dust-Stops. This replaceable filter eliminates cleaning, charging, draining, expert supervision, and the need to keep a supply of spares. Dust-Stops fit all types of air handling systems.



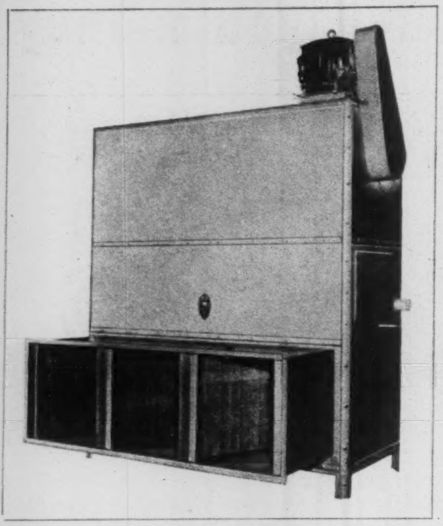
**6 You can pick up** Dust-Stops practically anywhere. Your air conditioning manufacturer, jobber or dealer always has a supply on hand. No waiting! Order your supply today. Or write: Owens-Corning Fiberglas Corporation, Toledo, Ohio. In Canada: Fiberglas Canada, Limited, Oshawa, Ontario.

## FIBERGLAS* DUSTOP* AIR FILTERS

*T. M. REG. U. S. PAT. OFF.

*Made by Owens-Corning Fiberglas Corporation, Toledo, Ohio*

SEE FIBERGLAS MADE: GLASS CENTER, NEW YORK WORLD'S FAIR, 1940



"Lindsay Structure." Its manufacturer builds no cabinets but fabricates and sells the necessary materials to specified dimensions and details.

The method represents a departure in putting together steel sheets and framing. The sheets are pulled into tension between the framing members to bind the entire structure rigidly together. The "pretensed" sheets instantly resist any movement of the framing and the load is distributed over the entire area, according to the manufacturer. The sheets are fastened to the framing without rivets or welds and the standard panel sheets, framing members and fittings can be assembled with simple wrenches.—Dry-Zero Corp., Merchandise Mart, Chicago, Ill.

### Brine Testing Set

No. 1953—Features of a brine testing set include improved accuracy and appearance, according to the maker. It utilizes the colorimetric method with universal indicator and there are 11 color standards covering a range from 5 to 10 pH in ½ pH increments. A new process is said to make the color standards less subject to fading and there is an arrangement provided for compensating colors in testing colored liquids such as dichromate treated brine. No technical training is necessary for the use of the set, it is stated, and any person who can match colors can make accurate pH determinations.

By proper control of pH and density of brine, corrosion in refrigerating plants can be reduced. Another use of such an instrument is to control the pH of treated water for ice making, and for lengthening the life of condenser tubes or coils by controlling pH of condensing water. The latter is of increased importance because of the ever growing use of cooling towers, spray ponds and evaporative condensers.—York Ice Machinery Corp., Roosevelt Ave., York, Pa.

### Stream-Lined Duct Work

No. 1954—A new type of "stream-lined" ductwork for use with air conditioning systems in stores, dining rooms and other sites where appearance is essential has been announced. Installed in the Famous Barr Co. in St. Louis (see photo) and a series of Montgomery Ward stores in the midwest, it has the appearance of a beam because of its entirely smooth surface, and it eliminates the expense of furring the ductwork under plaster and lath.

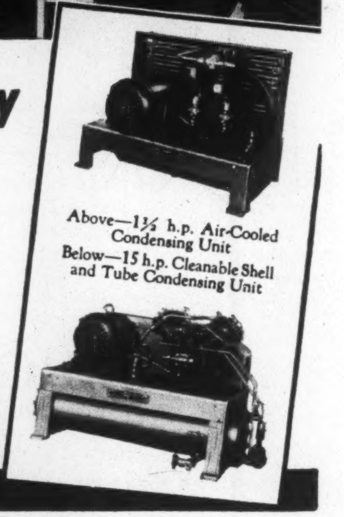
Other features of the ducts are the tightness of seams; the smaller amount of space they occupy, resulting in more headroom; the ease of decoration to blend with the decorating scheme of the room; and the ease with which they may be fitted into architectural plans, it is said. With the close fitting seams the

Tests that assure you the dependable, economical performance of
CURTIS
Condensing Units

**The Orifice Test for Volumetric Efficiency**

Every Curtis Compressor is given an individual test for efficiency according to standards of the Compressed Air Society. Curtis compressors must maintain a required pressure while running against loss of air through a calibrated orifice—the size of the orifice varying with the capacity of the compressor. This test is reflected in a water column reading that checks volumetric efficiency. The test takes place in an insulated, sound-proofed room where compressors are also checked for quietness in operation.

Curtis compressors that do not meet the exacting standards of this test are rejected by inspectors — one of many examples of the care and precision found in every step of Curtis manufacturing methods. The result is the long life, high efficiency and care-free performance of every Curtis Condensing Unit.



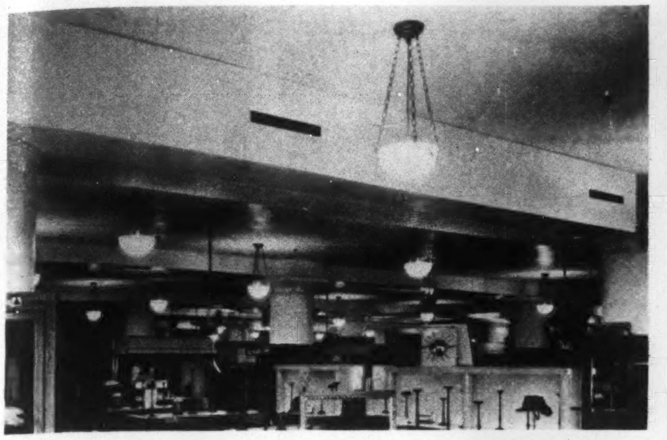
Above—1½ h.p. Air-Cooled Condensing Unit
Below—15 h.p. Cleanable Shell and Tube Condensing Unit

Write for full information.

**Curtis Refrigerating Machine Company**
1950 Kienlen Avenue St. Louis, Missouri
Established 1854

CURTIS REFRIGERATION AIR CONDITIONING AND COMMERCIAL

Division of Curtis Manufacturing Co.

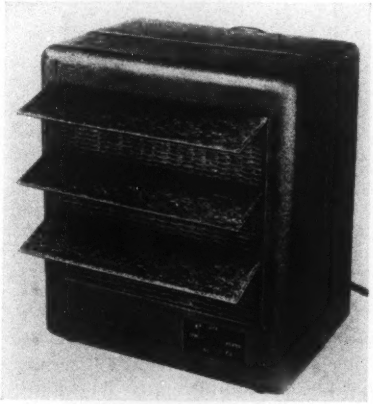


duct is effectively sealed to be air tight. The elimination of leaks permits the installed capacity of air handling equipment to be reduced, with consequent savings.

All seams are held together by flathead screws, the holes through all seams being drilled and on the outside duct surface counter sunk to permit a flat finish after sheet metal screws are in place. There are no outside seams or hangers. The latter, if needed, are inside the ducts. Seams are then filled with a cement or putty compound which will adhere to the metal. As the inside seams are flattened to assure smooth inside duct surfaces, the duct resistance is not increased a measurable amount. This procedure requires a higher degree of care in the construction of the ducts.—Carrier Corp., 302 S. Geddes St., Syracuse, N. Y.

### Electric Unit Heater

No. 1955—The new "Chromalox Type HF" blower unit heater may be supplied for either 115 or 230 volts, 60 cycles, single phase power, as specified. The 1500 watt units are supplied with 10 ft of heater cord and attachment plug connection to an ordinary outlet and all others except the 115 volt, 4000 watt heaters are supplied with 10 ft of cord. The 115 volt, 4000 watt units have line terminals to be connected to power supply.



A positive acting thermostatic switch automatically opens the heater circuit if normal operating temperatures are exceeded, and a manually operated reset button will close the circuit when normal temperatures are restored. A manual control switch will turn on the heating circuit and fan for winter use and the fan only for summer use. A thermostat for automatic temperature control is available.—Edwin L. Wiegand Co., 7610 Thomas Blvd., Pittsburgh, Pa.

### Boiler Feed Systems

No. 1956—Planned especially for boilers up to 750 hp and 200 lb pressure, a new line of automatic boiler return systems incorporates several features designed to help operators reduce fuel consumption, cut labor costs and increase plant efficiency, according to the manufacturer's announcement. These systems automatically return condensate to the boiler from both high and low pressure equipment, add make-up water as needed to compen-

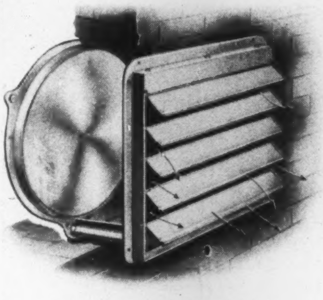
PIONEERING ILG LEADERSHIP

"Firsts"

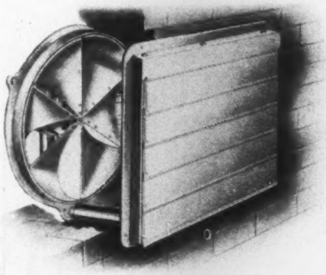
NUMBER 5 OF A SERIES

Automatic SHUTTERS

For Propeller Fans!



FAN RUNNING



FAN NOT RUNNING

Realizing that exhaust fans need automatic shutters to keep out snow and rain, ILG did something about it—way back in 1907! Here is the original Automatic Shutter and the leader right down through the years. Today, the Ilg Automatic Shutter is acknowledged to be outstanding from all standpoints—simplicity of design (nothing to get out of order) . . . dependability of operation . . . economy . . . full protection from the elements . . . built to withstand the weather.

Simple as "A, B, C", the shutter is held open by the air current when fan is running. When fan is idle, shutter automatically closes by gravity. Prevents wind pressure against fan from overloading or burning out motor.

Often copied . . . but never duplicated!

OTHER ILG "Firsts"

★ Placed direct-connected propeller fans on production basis—1906
★ Popularized direct-connected blowers—patented 1910
★ Floated drive for blowers —1932
★ Variable air control for blowers—1926
★ Type C (condenser-type) Motors—1925
★ Penthouses or power roof ventilators—1915
★ Motor operated shutter—1918
★ Solenoid operated shutter —1907
★ Propeller fan steam unit heater—1916.
★ Self - contained electric unit heater—1917
★ ILGATTIC system of summer cooling—1918
★ Portable type kitchen ventilating fans—1918
★ Built-in type kitchen ventilating fans—1925
★ Transom type kitchen ventilating fans —1925

Come to ILG "First" For Lasting Service

Completely weather-resistant, ILG Shutters are made with hard-rolled aluminum leaves, pressed on copper coated rods, supported in a heavy-duty cast-iron frame. Available in all sizes from 9½" to 72". For data and prices call your nearest ILG Sales Engineer, or write for Catalog F-482.

ILG ELECTRIC VENTILATING CO.
2841 N. CRAWFORD AVENUE, CHICAGO, ILL.
Offices in 42 Principal Cities

ILG Vitalized* VENTILATION AND AIR CONDITIONING

* AIR CHANGE . . . NOT JUST AIR MOVEMENT!

TEMPERATURE CONTROL
BUCKET TRAP

HERE'S HOW

Sarco Service Works

This washroom job looks simple. But it took three widely different Sarco products to meet the high standards set up by a chemical company in Milwaukee.

The Sarco Blender at the top mixes hot and cold water for a Bradley wash sink and the showers. The Sarco Temperature Regulator controls the temperature of the hot water service tank. The Sarco Bucket Trap drains the coils in the tank.

It worked satisfactorily on the first test. It has been "tested" without failure every time a worker has used the room.

**SARCO TEMPERATURE CONTROL** includes a complete line of self-operated thermostatic regulators for temperatures from 0 to 400 degrees; valve sizes from 3/8" to 8"; pressures up to 175 pounds. Ask for Catalog No. 52.

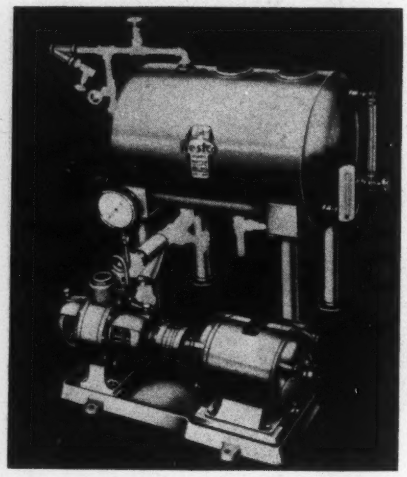
**SARCO INVERTED BUCKET TRAP** handles large volumes of condensate very rapidly and can be built for the highest steam pressures (up to 900 lbs.). Standard sizes 1/2 to 2 inch, 0 to 125 lbs. and 0 to 250 lbs. Ask for Catalog No. 165.

**SARCO HOT WATER BLENDER:** By mixing cold and hot water, it automatically provides blended water at any predetermined temperature regardless of the temperatures of the sources of supply. Used extensively for showers, washroom and hot water service lines. Also as a temperature control for cooling water on Diesel Engines and compressors. Ask for Catalog Nos. 140 and 197.

SARCO
SAVES STEAM

SARCO COMPANY, INC.
183 Madison Avenue, New York, N. Y.
SARCO CANADA LTD., FEDERAL BLDG., TORONTO, ONT.

97



sate for loss of live steam, maintain a uniform water level in the boiler, keep return lines open, and eliminate back pressure on return lines.

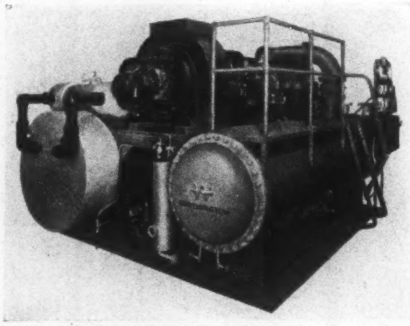
A turbine type pump having patented renewable liners is used. These liners permit alterations in performance without changing the entire unit, and also guard against breakdown losses.

The boiler water level control which is incorporated starts and stops the pump to maintain the water level within a 3/4 in. range, cuts off the burner or stoker if the water should reach a dangerously low level, and can be wired to sound an alarm when the low cut-off has been reached. The control has a "Monel" float and a specially constructed bellows to eliminate packing.

Additional equipment includes the receiver, stand, thermometer, gage, make-up valve and strainers.—Micro-Westco, Inc., Bettendorf Office Bldg., Bettendorf, Ia.

## Centrifugal Refrigeration Units

No. 1957—The successful performance of three installations of centrifugal refrigeration equipment for air conditioning service led the manufacturer to develop a complete line of such units in a range of capacities from 150 to 650 tons. One of the three installations is a three unit system of 1050 tons capacity.



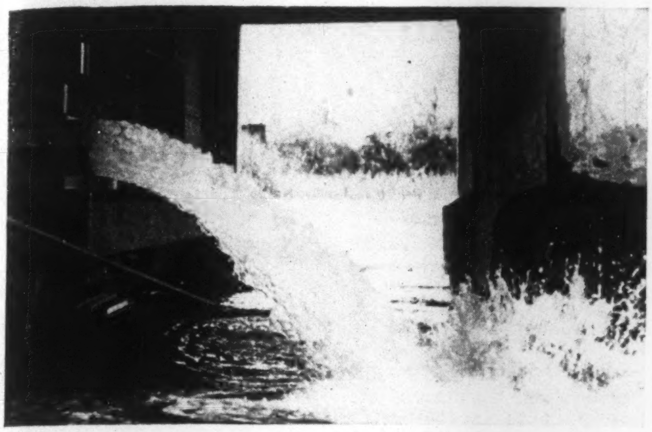
Impeller and casing designs of the new line incorporate modern practices in both hydrodynamics and centrifugal pump construction. Speeds are relatively low, ranging from 4000 to 5400 rpm, and pressures do not exceed 15 lb. "Freon-11" is the refrigerant.

A feature of particular interest is an auxiliary oil pump operating independently of the main drive, furnishing full pressure lubrication to all bearings during starting and stopping periods. In starting, the main power can be applied only after the auxiliary pump has developed its full pressure and in stopping, the pump is automatically cut in as soon as the main power is shut off.—Worthington Pump & Machinery Corp., Harrison, N. J.

## Unit Heaters

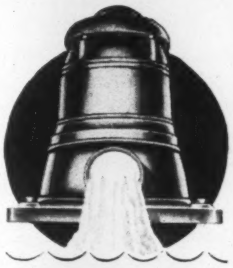
No. 1958—The "Webster-Nesbitt Little Giant" unit heaters are available in both down blow and horizontal blow types. In the first, the fan motor is vertical and the discharge air stream is directed downward. In the second, the motor is horizontal and the discharge air stream is directed at a slight downward angle with the horizontal, depending upon the adjustment of the louvers.

The objective of the design has been to combine the lightness and adaptability of propeller fan unit heaters with performance characteristics generally associated with blower fan heaters. They operate on the draw through principle, air entering the



## Solve Your Water Problems with

# LAYNE WELLS & PUMPS



A Water Supply System can be your very best—or very poorest investment. It all depends upon the efficiency, low operation cost, and long life of the wells and pumps you have installed. If you would eliminate all elements of doubt, then choose Layne Wells and Pumps.

Layne Wells and Pumps need not be bought on potential performance. Time has proven every feature of their construction, and in addition, there is the reputation of a world-wide organization as an extra guarantee. Before the drilling starts, you may know exactly how much water you will get—and at what cost per thousand gallons.

Another fine feature is the cooperation of Layne engineers, both in determining the quantity of water you may need and the amount that may be secured from wells located on your grounds. These engineers will also make dependable and valuable recommendations on the kind and size of wells and pumps best suited to fulfill your needs.

**AFFILIATED COMPANIES**

LAYNE-ARKANSAS CO. STUTTGART, ARK.
LAYNE-ATLANTIC CO. . . . NORFOLK, VA.
LAYNE-CENTRAL CO. . . MEMPHIS, TENN.
LAYNE-NORTHERN CO. . MISHAWAKA, IND.
LAYNE-LOUISIANA CO. LAKE CHARLES, LA.
LAYNE-NEW YORK CO. . NEW YORK CITY, AND PITTSBURGH . . . . . . PA.
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LAYNE-OHIO CO. . . . COLUMBUS, OHIO
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INTERNATIONAL WATER SUPPLY, LTD., LONDON . . . . . . ONTARIO, CANADA

For newest bulletins, catalogs and folders showing installations for the nation's foremost cities and industrial plants, address

LAYNE & BOWLER, INC.
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**PUMPS & WELL WATER SYSTEMS**

***For Municipalities, Industries, Railroads, Mines and Irrigation***

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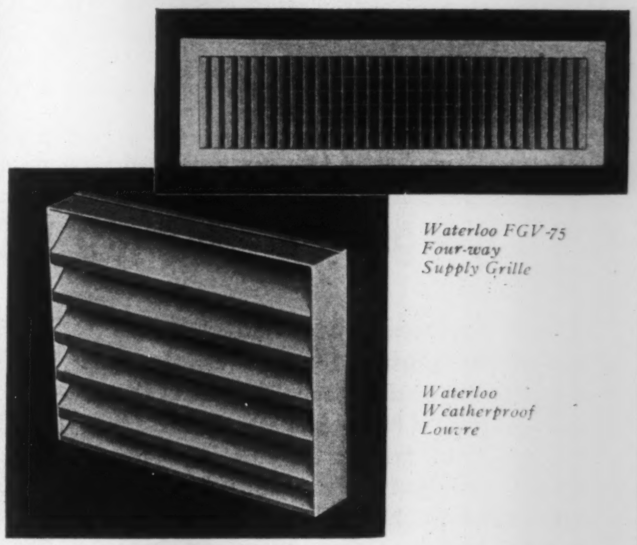
# For Every Air Diffusion Requirement—

**Waterloo**
AIR DIFFUSION EQUIPMENT



*Waterloo FGV-75 Four-way Supply Grille*

*Waterloo Weatherproof Louvre*

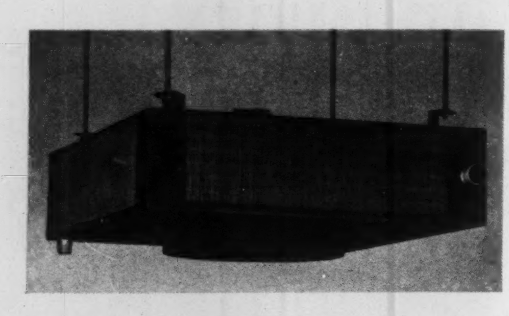
● Waterloo provides a complete variety of Air Diffusion Units to meet every kind of air distribution problem. Waterloo grilles, ceiling outlets, Techni-trol air volume dampers, deflecting vanes, and weather-proof louvres are just a few of the scientifically designed Waterloo Units available to help you improve the performance of your air conditioning installations. Take advantage of Waterloo's helpful engineering service. Write for details on the newest developments in Air Diffusion equipment.

**WATERLOO REGISTER COMPANY**
Waterloo, Iowa Seattle, Wash.
Representatives in all Principal Cities

*"The Final Factor in Successful Air Conditioning"*

unit through a four sided heating element, which provides large intake areas and a high Btu capacity in a compact space.

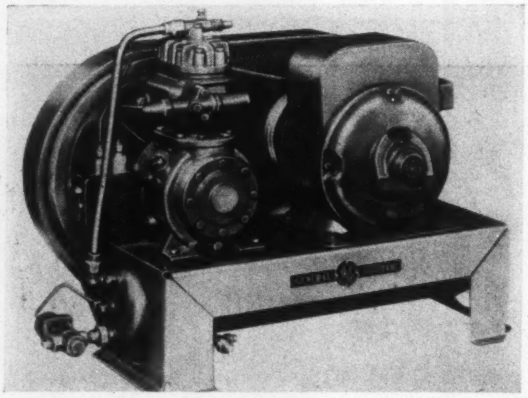
Use of the down blow type is in general indicated when the presence of cranes or other machinery requires the unit and piping to be well above the floor level and usually near the roof trusses, the manufacturer states. Application of the horizontal blow unit follows those principles of heat distribution regularly employed with the suspended blower type of unit heater, with the unit located closer to the working zone than is the case with the down blow unit.—Manufactured by John J. Nesbitt, Inc., State Rd. and Rhawn St., Philadelphia, Pa. Distributed in U. S. A. by Warren Webster and Co., 17th and Federal Sts., Camden, N. J.



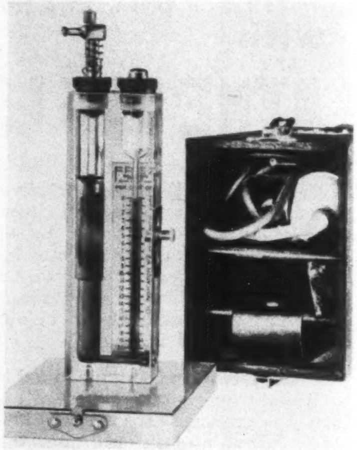
### Condensing Units

No. 1959—Refrigerating capacities have been increased approximately 25 per cent in a new line of commercial condensing units which are easier to install, lighter in weight, and improved in appearance, according to the manufacturer. The addition of 10 new types brings the complete line, including both air and water cooled units, to 24 sizes ranging from ¼ to 3 hp. (There are also condensing units up to 60 hp for large refrigeration and air conditioning systems.)

Capacity increases in the new line are attributed to refinements in engineering design, notably in a new valve and valve plate assembly and in the condensers.—General Electric Co., Air Conditioning and Commercial Refrigeration Dept., 5 Lawrence St., Bloomfield, N. J.



### $CO_2$ Indicator



No. 1960—A new carbon dioxide indicator is machined from a solid block of clear plastic with metal parts of stainless steel. The absorbent solution is a brilliant red in color, and its level is reflected from a polished scale to prevent possibility of parallax error. Only three simple steps are involved in using the indicator, which is accurate to within ½ per cent $CO_2$, the maker states.

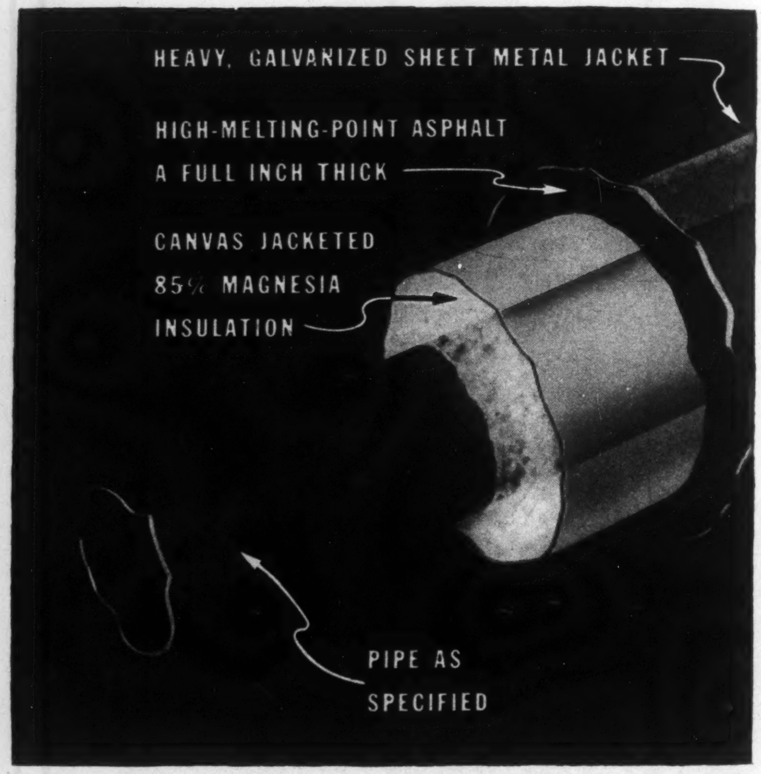
FOR UNDERGROUND STEAM SERVICE...

**Here is a system of pre-insulated and pre-sealed piping that is efficient, dependable and economical. It is the DURANT INSULATED PIPE system that comes to you in completely finished units, ready for field installation. No tile or tunnels required and nothing extra to buy. Pipe supports are sealed within the units and the Durant System can be laid with a minimum of trenching and field work. The asphalt protection is permanently waterproof, and the insulation will maintain its efficiency and last as long as the pipe itself.**

**Write today for the Ehret D. I. P. booklet giving full details.**

**EHRET MAGNESIA MANUFACTURING CO.**

**VALLEY FORGE • PENNSYLVANIA**

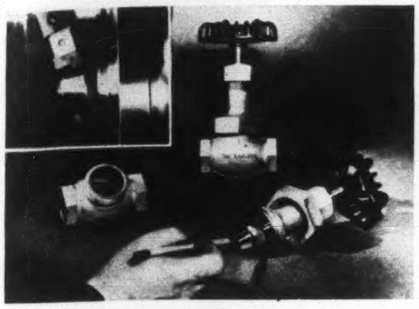

HEAVY, GALVANIZED SHEET METAL JACKET
HIGH-MELTING-POINT ASPHALT A FULL INCH THICK
CANVAS JACKETED 85% MAGNESIA INSULATION
PIPE AS SPECIFIED

DISTRIBUTORS IN ALL PRINCIPAL CITIES

It is supplied complete with a carrying case in which space is also provided for a stack thermometer and a full-size draft gage, both of which may be purchased separately.—Julien P. Friez & Sons, 4 N. Central Ave., Baltimore, Md.

### Valve Finish

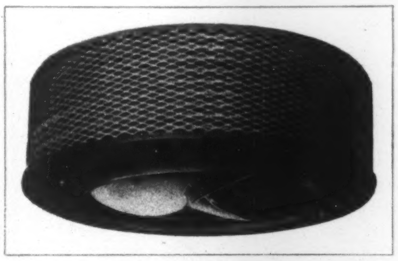
No. 1961—Through the use of a new development of the automotive industry—"Superfinish"—the life of valve seats and discs in the line of "500 Brinell" valves has been increased twelve-fold, according to the maker. The process produces a highly polished wearing surface by honing, which it is stated eliminates almost the last trace of friction.



Special "Superfinish" machines have been developed and a close-up of one applying the finish to a valve disc is shown in the upper left of the illustration.—Hancock Valve Div., Manning, Maxwell & Moore, Inc., Bridgeport, Conn.

### Vertical Projection Unit Heater

No. 1962—The new vertical projection type unit heater illustrated incorporates a number of improvements suggested by the experience of the manufacturer's engineers as well as users. The circular type of vertical heater is particularly adapted to the spiral fin tube construction as used by the manufacturer, because the shape and design of the fin creates air turbulence without undue restrictions, it is stated. Copper fins are metallically bonded to the copper tubes and the contact is further enhanced by winding the fin under tension upon the tube.

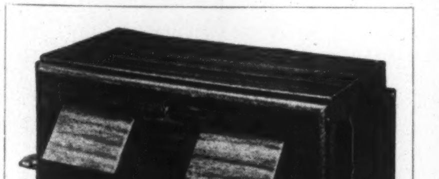


According to the announcement, the heating elements are tested to 2000 lb hydrostatic pressure and are guaranteed for 200 lb saturated steam pressure. "Torrington" quiet operating fan blades are used.—McCord Radiator & Mfg. Co., 2587 E. Grand Blvd., Detroit, Mich.

### Window Ventilating Unit

No. 1963*—A new window ventilating unit for year 'round operation in homes, offices, hospitals and sanitariums is known as the "Ventil-aire." It takes in outside air and filters it before circulating it throughout the room, and is said to provide relief for asthma and hay fever sufferers.

During the heating season, deflectors may be set to direct incoming cool air toward the ceiling to mix with warm air in order to eliminate drafts. It is possible to recirculate inside air to help maintain an even room temperature.



Maximum air delivery is 500 cfm at top speed, with a minimum air delivery of 90 cfm at low

Efficienc

... THEN BEAUTY

IN AIR DISTRIBUTION

Everything in the tastefully designed restaurant pictured here must lend its touch of beauty to the whole. Notice how unobtrusively the Aerofuse Outlets become a part of the lovely decorative scheme! But it is small wonder they were selected for this installation when their functional superiority is taken into account. Efficiently they provide, (1) Maximum Air Mixture; (2) Rapid Temperature Equalization; (3) Perfect Air Distribution; (4) Total Elimination of Drafts.

.... And Now

A SUPPLY AND RETURN UNIT

Valuable in installations where simplification of the duct layout is of primary importance. Supply and return (exhaust) ducts can be run to the same point.

AEROFUSE OUTLET

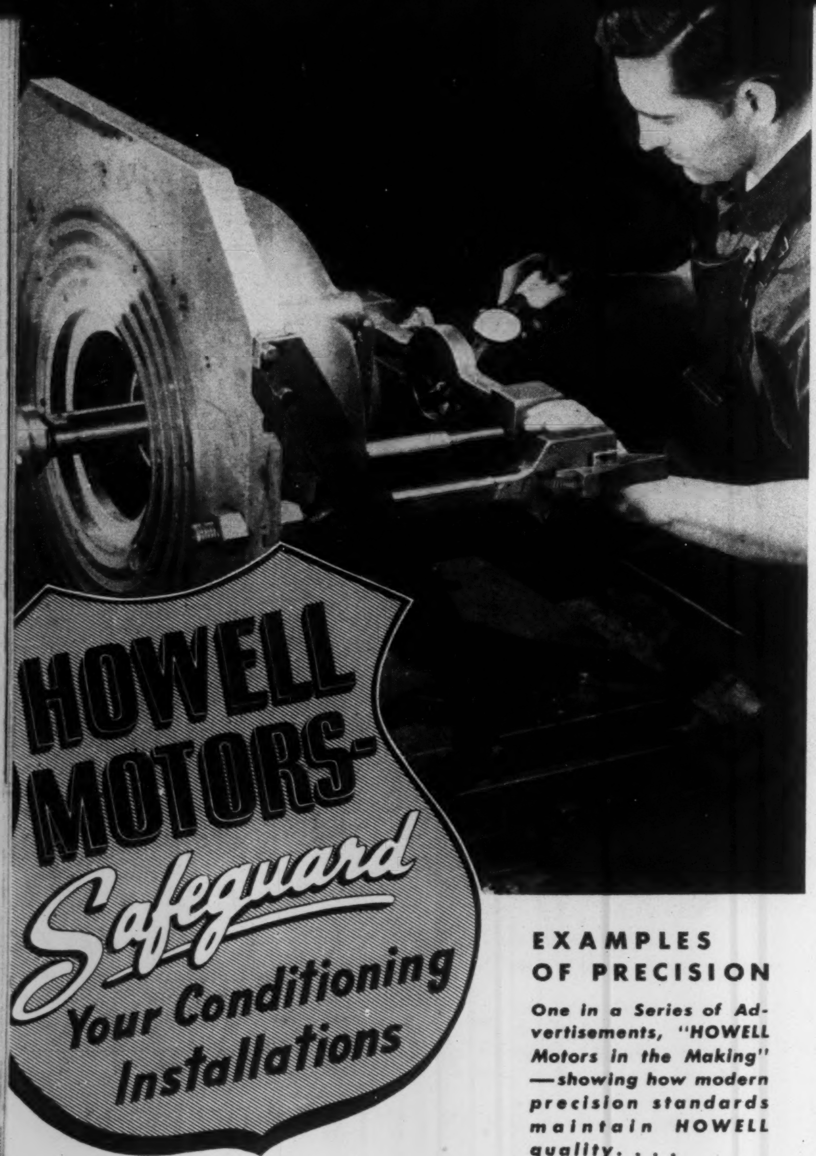
by

T & B

TUTTLE & BAILEY, Inc.

NEW BRITAIN, CONN.

NEW YORK CHICAGO PHILADELPHIA



**EXAMPLES OF PRECISION**

**One in a Series of Advertisements, "HOWELL Motors in the Making"—showing how modern precision standards maintain HOWELL quality. . . .**

BEARING HOUSINGS DIAMOND BORED

*...Insuring Perfect Alignment*

**Misalignment of working parts is one of the chief causes of noise and rapid wear in an electric motor. HOWELL takes definite steps to prevent it.**

**We insure perfect alignment of all motor bearings, either sleeve or ball. This is first done by reaming, then DIAMOND BORING. The diamond boring operation is illustrated above, and work is held within tolerances of .0003 inches.**

***This is one of the many precision methods employed at HOWELL to provide QUIET OPERATION, and trouble-free motor performance year after year.***

*Complete Line — Fast Delivery*

**For 25 years HOWELL has specialized on polyphase motors for air conditioning, ventilating and heating drives. Motors can be furnished with any electrical and mechanical characteristics required — ½ to 150 HP, single or multi-speed.**

***Whatever your drive needs, HOWELL can meet them EXACTLY and on time. Write us, outlining your particular problem!***

HOWELL ELECTRIC MOTORS COMPANY
HOWELL, MICHIGAN
*Representatives in All Principal Cities*

speed, the maker states. The unit is 10½ in. high and 13½ i deep and is finished in walnut color. A special ivory finish i also available. —Fairbanks, Morse & Co., 600 S. Michigan Ave Chicago, Ill.

### Pipe Machines

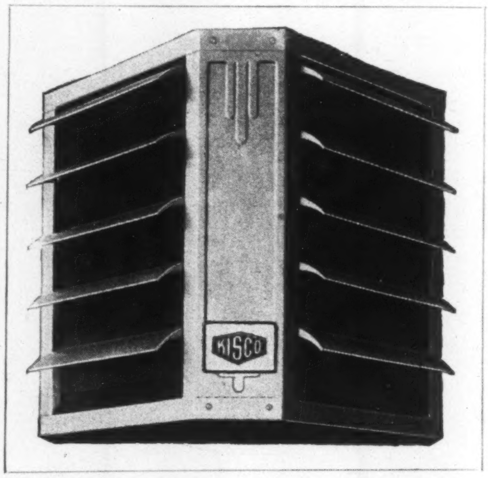
No. 1964—A recent addition to the manufacturer's line o portable pipe machines is known as the "No. 502 Pipe Master." It is equipped with a new sliding floating type of die head whic is adjustable and quick opening. According to the manufacturer, it is possible to handle nipples as short as 3½ in. in the 2 in. siz without the use of a special metal chuck.

A cone fluted reamer of new design is mounted on the front of the die head, and is said to enable the operator to handle close work easily and efficiently. To assist the front gripping chuck in centering the longer lengths of pipe, the machine is equipped with a three jaw centering chuck on the rear of the spindle.

Overall length of the machine is 46 in., width 19½ in. and height 18 in. Net weight complete is 280 lb, and with carriage removed, 215 lb.

The same manufacturer has also announced a new electric sewer and pipe cleaning machine capable of removing stoppages several hundred feet from the opening even when it is necessary to pass through elbows and traps. Overall length of this machine is 15 in., width 15 in. and height 14 in. Net weight is 85 lb.—Oster Mfg. Co., 2057 E. 61st Pl., Cleveland, Ohio.

### Heat Recirculator



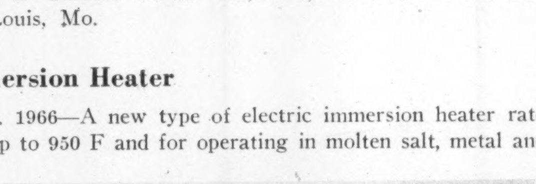
No. 1965—A V-type heat recirculator known as the "Q-T" has been announced for installation in large spaces such as warehouses, garages, auditoriums, factories, stores and offices. Instead of a single warm air stream, the unit projects two streams of heated air at right angles to each other. Only one motor, one fan and one inlet and outlet connection are employed.

The headers are of semi-steel with inlet and outlet integrally cast. The copper tubes have rigid copper fins mechanically bonded and the tubes are joined to the header castings by compression fittings. The design provides for individual expansion of the tubes.

Two sets of streamlined louvers are used to direct the heated air to the proper level and are adjustable or can be locked in place if desired.—Kisco Co., Inc., 39th and Chouteau Ave., St. Louis, Mo.

### Immersion Heater

No. 1966—A new type of electric immersion heater rated for use up to 950 F and for operating in molten salt, metal and high

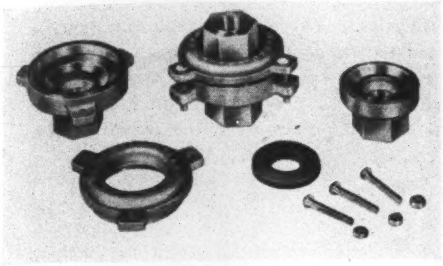


temperature oil baths, has been announced. Heavy duty tubular units are welded to an electrical connection housing to which a riser is attached, connections being brought out to the terminal box in which line connections are made.

Operating conditions determine the use of steel or "Inconel" sheath, 1/16 in. in thickness with wattage ratings from 2 to 5 kw at various watt densities.—Edwin L. Wiegand Co., 7610 Thomas Blvd., Pittsburgh, Pa.

### Swing Joint for Steam Lines

No. 1967**—For handling steam pressure up to 100 lb, a simple swing joint has been developed. The sealing unit is a specially shaped and compounded rubber gasket containing a percentage of finely divided metallic lead milled directly into the rubber. Because the lead acts as a lubricant, the joint turns freely under pressure, the maker states. The gasket is expanded slightly by the heat, which helps to maintain a seal.



The joint is made of heavy bronze, weighs approximately 4½ lb, and is available only in the ¾ in. straight style.—Patterson-Ballagh Corp., 1900 E. 65th St., Los Angeles, Calif.

### V-Belt Prevents Static

No. 1968—A v-belt manufactured so as to prevent accumulation of static, and to retain its static discharging qualities during its service life, has been announced. It will be sold, for the present, only to machine or equipment makers. It is of greatest interest and importance where static discharges might create a fire hazard. These include gasoline pumps, other service station equipment, and machines in chemical, explosive and milling plants, the manufacturer states.

One of the important features of the new v-belt is the absence of any danger of the belt acting as a "short" between the motor and its operator, says the maker, who states the resistance built into the belt is just enough so that the belt itself cannot act as a direct passage for current.—B. F. Goodrich Co., 548 S. Main St., Akron, Ohio.

### Bearing Maintenance

No. 1969—When the burned out bearing for a large ventilating fan serving an office building was replaced it was found that the shaft had scored so badly that the bearing would not hold oil. Removal of the fan for shaft replacement would have been extremely costly and difficult due to extremely close quarters and would have left the building without ventilation for a considerable period of time.

Tightening the bearing to stop the leak by removing the shims resulted in excessive heating of the bearing. Heavier grades of oil proved ineffective in maintaining lubrication.

It then occurred to the chief engineer that if a "dry" lubricating film could be imposed on the bearing, the shaft could gradually be run in again without scoring the bearing. "Oildag," consisting of colloidal graphite in oil, was added to the lubricating oil and the fan was run first with the shims in place and later without the shims. At the end of four weeks of operation, the oil leak had stopped and the shaft and bearing were running cool, indicating that the proper bearing surface had been restored, protected by the formation of a "graphoid" lubricating film on the surface of the bearing and shaft.—Acheson Colloids Corp., Port Huron, Mich.

No noisy ducts in this
NEW DETROIT EDISON BUILDING

All air-conditioning ducts quieted with J-M AIRACOUSTIC SHEETS

**NEW DETROIT EDISON BLDG., Detroit, Mich. In this building, as in hundreds of others, the air-conditioning system is quieter because J-M Airacoustic Sheets are used as duct linings. Basically mineral, this modern material resists both moisture and fire. The building was designed by the Detroit Edison Co. Buensod-Stacey Air Conditioning, Inc., were air-conditioning contractors.**

**Unusually fire-resistant and sound-absorbent, this J-M lining material prevents the nuisance of noisy ducts in new Detroit Edison Building, Detroit, Michigan.**

IN this new Detroit Edison Building, the owners made sure noise would be *absorbed* . . . not carried . . . in the air-conditioning system by lining the main ducts with J-M Airacoustic Sheets. Basically mineral, Airacoustic will not flame . . . introduces no fire hazard. Highly sound-absorbent, it eliminates more than 70% of all noise in ducts. Its high moisture resistance provides full protection against humidity.

Airacoustics's large-size units and simple application method make installed cost so low you can include duct quieting in every estimate. It will pay you to get complete details. Write for recently-published brochure, AC-23A. Address Johns-Manville, 22 E. 40th Street, New York, N. Y.

**EASY TO HANDLE,** J-M Airacoustic Sheets are quickly installed at low cost.

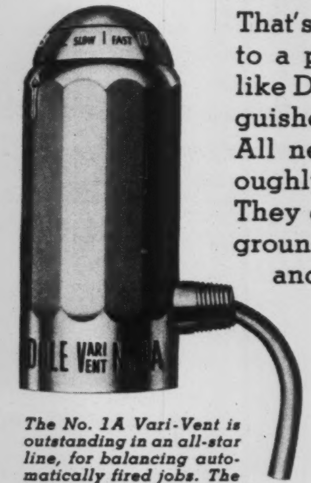
JOHNS-MANVILLE JM PRODUCTS Johns-Manville
AIRACOUSTIC SHEETS FOR DUCT LININGS

PLAY SAFE

*Your Jobs Are Only As Good As Their Valves*

**In the finished installation, the steamfitter's reputation for good work is all wrapped up in the same package with the ability and integrity of the air valve manufacturer. The performance of the job is judged as a whole, yet it can be no better than the air or vacuum valves permit. They'd better be good.**

**That's why it's good sense to stick to a precision-engineered line like Dole. These valves are distinguished for their fine performance. All new features are tested thoroughly before passing them along. They come to you with the background of a national reputation and a strong guarantee policy.**



*The No. 1A Vari-Vent is outstanding in an all-star line, for balancing automatically fired jobs. The new domed adjustment cap adds eye-appeal—improves venting.*

*Get details from your jobber on the complete line with a full range of prices for every possible variation of modern radiator installation.*

**THE DOLE VALVE COMPANY**
**1901-41 Carroll Ave., Chicago, Ill.**
**Offices and Representatives in all Principal Cities**

DOLE
*Air and Vacuum*
VALVES

### Synthetic Tubing

No. 1970—A special line of hose or tubing made from "Koroseal," a synthetic elastic material with rubber-like qualities, has been announced. The hose is made without fabric or any other wall reinforcement and is stocked in inside diameters ranging from ⅛ in. to ½ in. and 1/16 to ⅛ in. wall thickness. It can be made in all sizes up to 3 in. outside diameters.

According to the manufacturer, the hose shows durometer hardness 70 to 78 at 85 F, specific gravity 1/31, working pressure 50 lb at temperatures up to 120 F. The recommended working pressure of 50 lb per sq in. is based on a safety factor of five, it is stated.

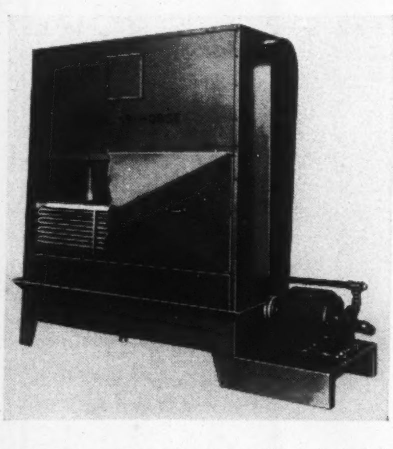
Among the uses of the hose are installations in chemical laboratories and plants, in electrolytic ore reduction plants and other electrochemical metal refineries. Three years ago an experimental length was supplied to one of the large Canadian copper refineries to be used as a flexible coupling on the spill pipes of the cascades on electrolytic cells. Thirty months later the plant reported no deterioration from the electrolyte, the manufacturer states.—B. F. Goodrich Co., 548 S. Main St., Akron, Ohio.

### Heavy Duty Torch

No. 1971—A recently developed torch for soldering copper pipe fittings over 6 in. in diameter, thawing large pipe and for heavy copper tank work, is capable of delivering 200,000 Btu per hr with a flame ranging from 6 to 24 in. in length, according to the manufacturer.

The new torch is light in weight (approximately 3 lb) and it is stated that its controlled flame will not blow out.—Insto-Gas Corp., 1900 E. Jefferson Ave., Detroit, Mich.

### Cooler for Diesel Engine Jacket Water



No. 1972—A new diesel engine jacket water cooler uses the principle of heat dissipation by evaporation of water. It consists essentially of a coil through which the jacket water is passed, nozzles to spray water on the coil, and a blower to force air past the coils. In operation the hot jacket water enters the cooling coil at the top of the cooler, water from another source is sprayed over the coil from one end and air is blown in from the other end. As the water outside the coil evaporates, it cools the coil and the jacket water which is then returned to the engine. The sprayed water is constantly recirculated so that the actual amount consumed is only about 2 lb per 1000 Btu of engine heat absorbed.

This evaporative cooler is designed primarily for indoor operation although units for outdoor installation may be secured with cooling coils of the finned type to permit air cooled operation through the winter season. The finned type coolers may also be used indoors in winter to heat occupied spaces through branch lines of the air discharge duct.—Fairbanks, Morse & Co., 600 S. Michigan Ave., Chicago, Ill.

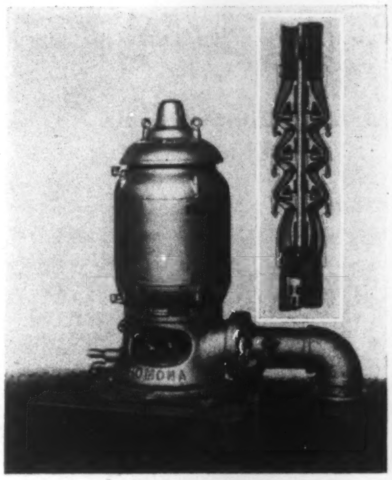
### Sound Level Meter

No. 1973—A new light weight, portable sound level meter of compact design has a range of 24 to 120 decibels. It is offered for almost any kind of noise study, including sound in theaters, auditoriums, and radio studios, and noises of motors, fans, pumps,

bearings and other machinery parts.

Essential elements of the device are a microphone, an amplifier and an indicating instrument. An arm extension protects the microphone from sound reflected from the case. The instrument is designed to perform in accordance with standards of the American Standards Association for sound level meters.—General Electric Co., 1 River Rd., Schenectady, N. Y.

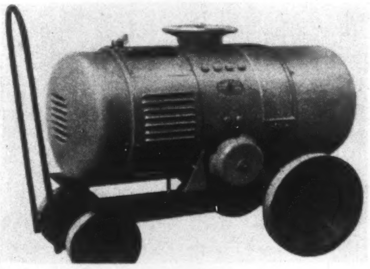
### Vertical Turbine Pumps



No. 1974—Complete redesign of a line of 6 in. medium capacity vertical turbine pumps has included new impellers and seats which afford higher efficiency and better performance. For a desired capacity of 100 gpm against 110 ft lift in a well and 50 lb pressure above, a 7½ hp motor is required as against a 10 hp motor with the old model.

Features of the pumps include water lubrication, with no stuffing box below ground level, semi-open impeller adjustable from the surface for wear and for changing capacity, and the non-sandlocking and non-gaslocking design.—Pomona Pump Co., 206 E. Commercial St., Pomona, Calif.

### Dual Voltage Switch for Arc Welders



No. 1975—A new dual voltage switch for installation on arc welding machines such as the "Hornet," when they must be used on either of two line voltages at different times, has been announced. It can be used on any motor employing a-c current provided the motor and starter are reconnectable for two voltages.

With the switch installed, the change can be made in less than a minute, states the maker. Raised figures on the switch base indicate the line voltage for which it is set.—Wilson Welder & Metals Co., Inc., 60 E. 42nd St., New York, N. Y.

### Pump Mount Motor

No. 1976—Development of a new line of motors with standard dimensions designed for the easy mounting of centrifugal and similar pumps has been announced, with ratings from ½ to 40 hp inclusive for operation on three phase at two, four and six pole speeds. Extended shafts and machined fits for pump mounting are all standard and are the same dimensions throughout the entire range of ratings. There is a neoprene washer on

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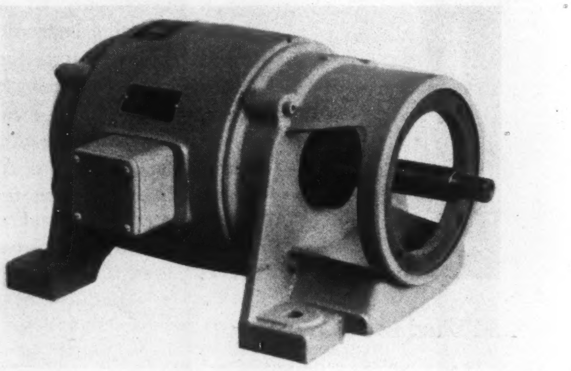
the shaft between the pump packing and the motor bearing i combination with a trough cast around the bearing which makes it impossible for any material pumped to find its way into the motor bearing in the event of packing looseness or wear, according to the maker.



The projecting shaft is covered with a special stainless steel tube ground and polished at the time the shaft is made.—Sterling Electric Motors, Inc., 5401 Telegraph Rd., Los Angeles, Calif.

## Air Conditioning Units

No. 1977—The illustration shows a view of the assembly of "Weathermaster" air conditioning units for the new Lafayette Building in Washington, D. C. The 1314 units for this building are said to be the largest number ever to be installed at one time in a privately owned, new building. In addition to these units, two of the manufacturer's 810 ton centrifugal machines will be installed.

This 14 story structure in Washington, D. C., is to house offices of the Reconstruction Finance Corp. in addition to a restaurant and general offices. The consulting engineer is W. K. Karsunky and the air conditioning contractor is Raisler Corp.—Carrier Corp., 302 S. Geddes St., Syracuse, N. Y.

## Pyramidal Base Motor

No. 1978—According to the manufacturer, the design of a new pyramidal base motor does away with the possibility of misalignment which might develop in connecting a horizontal centrifugal pump to the motor, as the mounting is an integral part of the motor. The motor support on which the pump casting is attached carries the load of the pump instead of permitting any of the weight to be imposed on the shaft.

Simplicity has been achieved by reduction of a number of parts; no coupling is required, and one shaft only is used. Two large ball bearings take the radial and thrust loads and are positively lubricated.

The new design can be used not only for mounting pumps, but for any machine where perfect alignment is essential, the maker states.—U. S. Electrical Motors, Inc., 200 E. Slauson Ave., Los Angeles, Calif.

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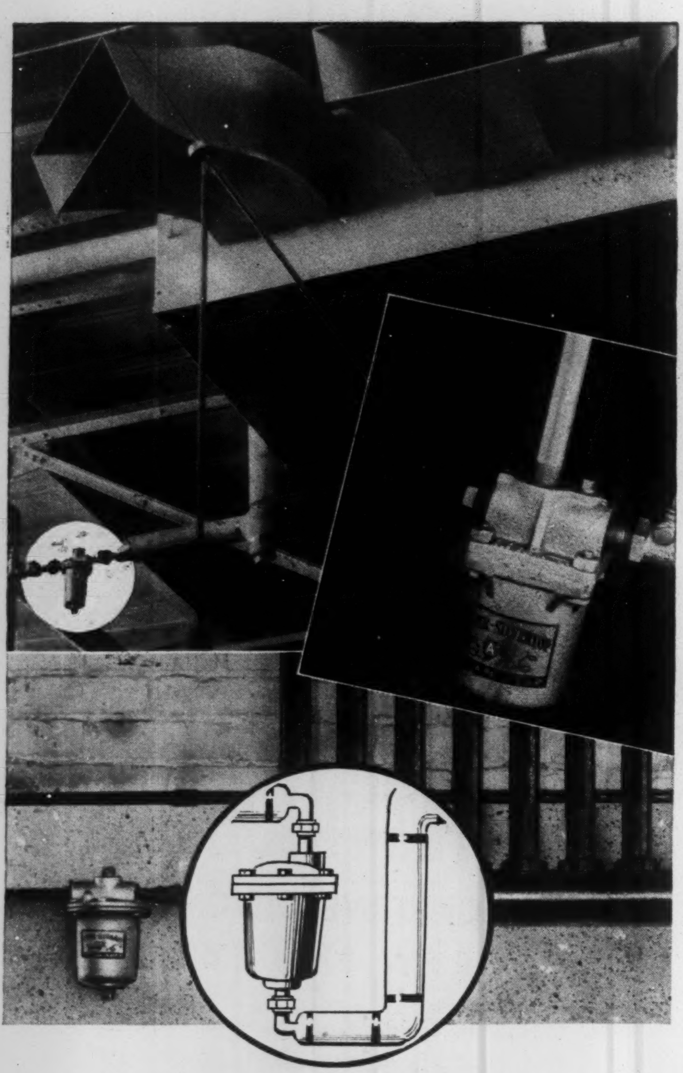

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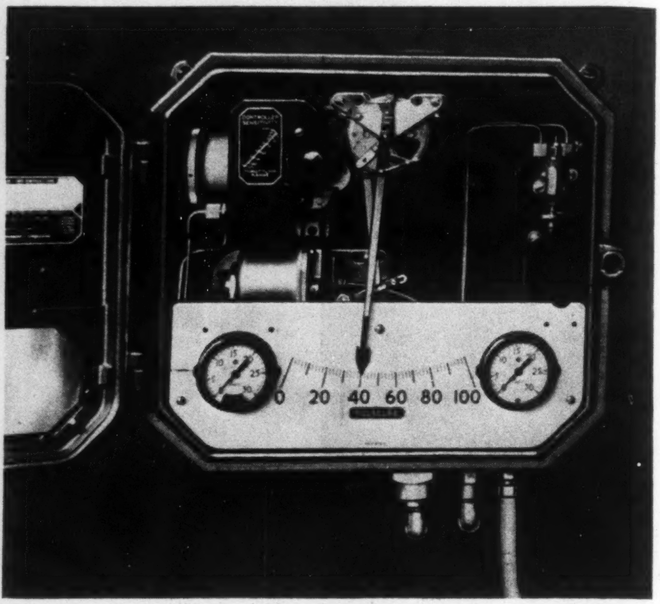
### Remote Pneumatic Transmission Systems

No. 1979—A simple and accurate means of indicating, recording or controlling process variables remote from the point of measurement is offered by a new remote pneumatic transmission system. This system of remote transmission is particularly advantageous where it is desirable to correlate temperature, pressure, flow or liquid level data on a centralized panel or in a control room, the maker says.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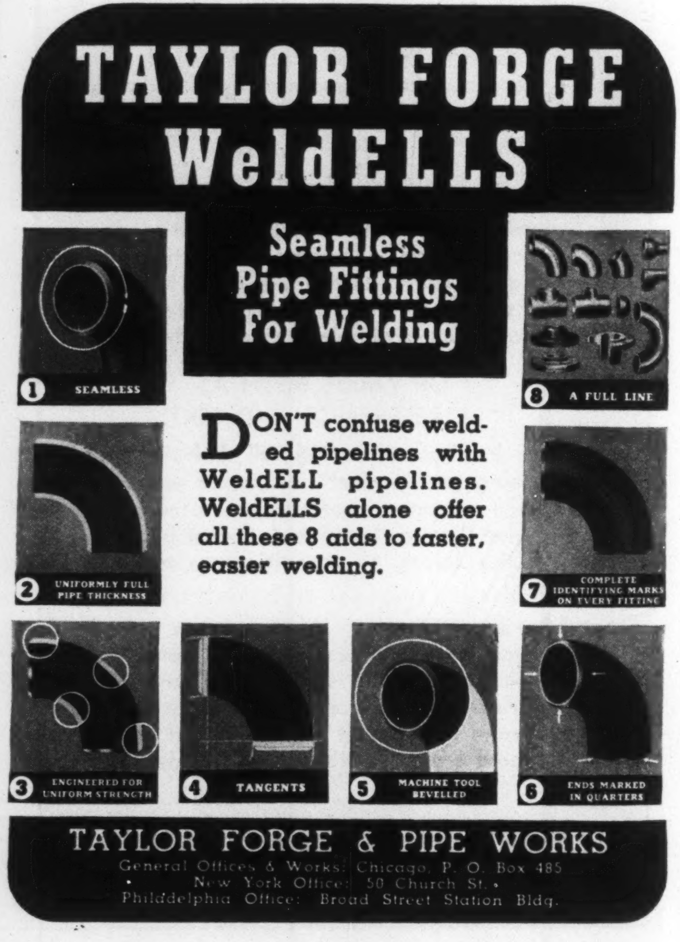
The system utilizes standard instruments. It may consist of



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one or two transmitters connected to a receiver; or one or more receiving instruments, not necessarily near each other, and as far as 1000 ft from the transmitter. Transmitters or receivers may be indicating, recording or controlling types. Air pressure is the transmitting medium, with ¼ in. OD copper tubing as the means of connection.

The method is accurate within ± 1 per cent of the scale range when properly installed, it is stated. The speed of response of the receiver to changes in output air pressure from the transmitter is largely dependent upon distance—the maximum lag being one second per hundred feet of connecting tubing.—Taylor Instrument Companies, 95 Ames St., Rochester, N. Y.

## Conventions and Expositions

*American Gas Association:* Convention, October 7-10, Atlantic City, N. J. Headquarters office, 420 Lexington Ave., New York, N. Y.

*American Society of Heating and Ventilating Engineers:* Fall meeting, October 14-15, Rice Hotel, Houston, Tex. A. V. Hutchinson, secretary, 51 Madison Ave., New York, N. Y.

*American Welding Society:* Annual meeting, week of October 20, Cleveland Hotel, Cleveland, Ohio. Headquarters office, 33 W. 39th St., New York, N. Y. Tentative program includes papers on welding of carbon-molybdenum piping for high pressure, high temperature service, by R. W. Emerson; pipe welding for naval service, by Bela Ronay; arc and gas welding piping, by Eric Seabloom; and codes for welding pressure vessels, by D. S. Jacobus.

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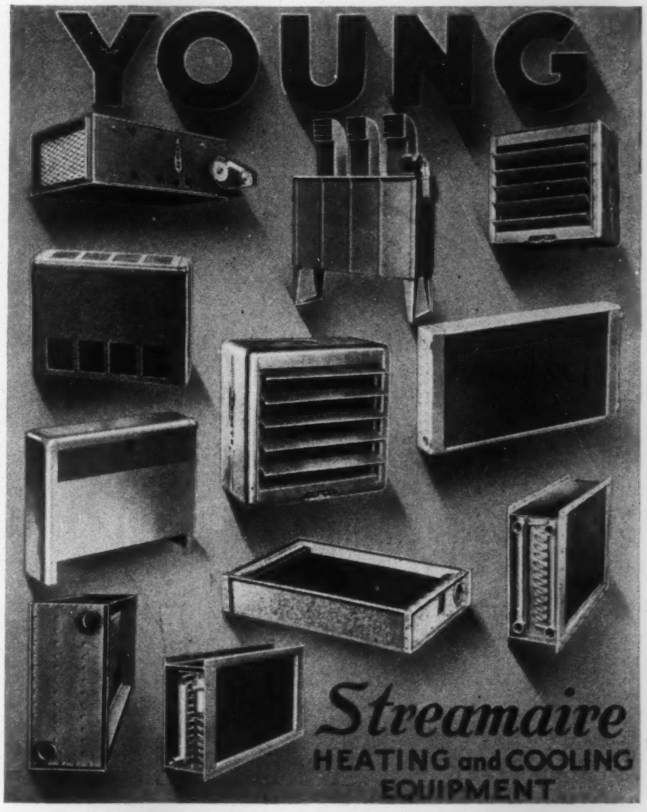

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*American Society of Mechanical Engineers:* Annual meeting, December 2-5, Hotel Astor, New York, N. Y. Headquarters office, 29 W. 39th St., New York, N. Y.

*Power Show:* 14th National Exposition of Power and Mechanical Engineering, December 2-7, Grand Central Palace, New York, N. Y. Under management of International Exposition Co., Grand Central Palace, New York, N. Y.

*American Chemical Exposition:* December 11-15, Stevens Hotel, Chicago, Ill. Under auspices of Chicago section, American Chemical Society. Exposition manager, Marcus W. Hinson, 110 N. Franklin St., Chicago, Ill.

*Refrigeration and Air Conditioning Exhibition:* January 13-16, Stevens Hotel, Chicago, Ill. Sponsored by Refrigeration Equipment Manufacturers Association, R. M. McClure, executive secretary, 111 W. Washington St., Chicago, Ill.

*American Society of Heating and Ventilating Engineers:* Annual meeting, January 27-29, Hotel Muehlebach, Kansas City, Mo. A. V. Hutchinson, secretary, 51 Madison Ave., New York, N. Y.

*National Oil Burner Progress Exhibition:* March 17-22, Commercial Museum, Philadelphia, Pa. Official hotel headquarters, Hotel Benjamin Franklin. Sponsored by Oil Burner Institute, 30 Rockefeller Plaza, New York, N. Y.

*American Society of Heating and Ventilating Engineers:* Semi-annual meeting, week of June 16, San Francisco, Calif. A. V. Hutchinson, secretary, 51 Madison Ave., New York, N. Y.

*Pacific Heating and Air Conditioning Exposition:* June 16-20, Exposition Auditorium, San Francisco, Calif. Under auspices of American Society of Heating and Ventilating Engineers, and under management of Charles F. Roth, International Exposition Co., Grand Central Palace, New York, N. Y. Walter L. Fleisher is chairman of the advisory committee.

*American Society for Testing Materials:* Annual meeting, and exhibit of testing apparatus, June 23-27, Palmer House, Chicago, Ill. Headquarters office, 260 S. Broad St., Philadelphia, Pa.

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## Book Reviews

### Simple Blueprint Reading

[Simple Blueprint Reading with Special Reference to Welding. 1st ed. 1940. 138 pp., 6 x 9 in., semi-flexible simulated leather cover. Published by Lincoln Electric Co., 12818 Coit Rd., Cleveland, Ohio. Price, 50 cents in U. S. A., 75 cents elsewhere.]

This new book offers a basis for study of blueprint reading which, together with practice in the actual reading of drawings, will guide the student to proficiency. While compiled and published primarily for welders, it contains information of value for anyone concerned with mechanical construction. The text is concisely written in practical language and over 160 illustrations are included.

A comprehensive explanation is given of various symbols used in drawing of different types of welded joints and illustrations include practical examples of drawings of a number of machine parts, pipe connections, general construction, tanks, etc. There are also questions and answers to allow the reader to test his knowledge.

## Booklets, Reports and Papers

### Federal Specification for Pipe

Copies of the Federal Specification for Pipe; Steel and Ferrous-Alloy, Wrought, Iron-Pipe-Size (Federal Standard Stock Catalog, Section IV, Part 5, WW-P-403a) may be obtained from the Superintendent of Documents, Washington, D. C. for 5c. This specification became effective July 15 and supersedes Federal Specification WW-P-403. It was approved by the Di-

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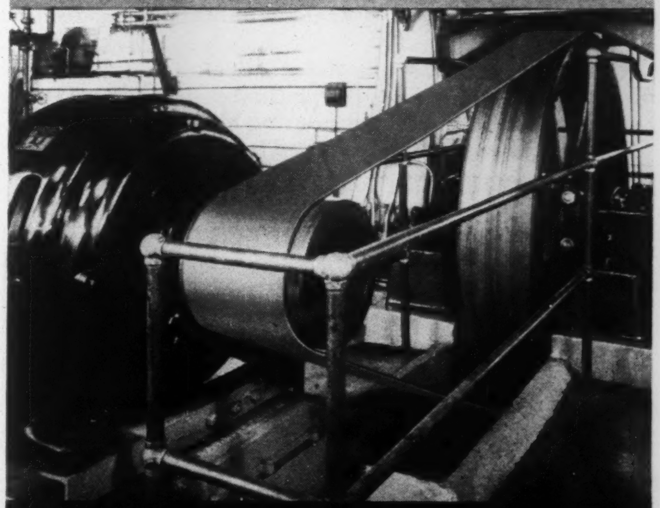

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## Effect of Soot on Boiler Rating

Report BMS54 of the Building Materials and Structures series of the National Bureau of Standards is entitled Effect of Soot on the Rating of an Oil Fired Heating Boiler; it was prepared by Richard S. Dill and Paul R. Achenbach. It is four pages in length and can be had from the Superintendent of Documents, Washington, D. C., for 10c.

It is shown that the rating of a boiler, obtained by a test method based on constant flue gas temperature, can be seriously affected by soot on the heating surfaces, although the soot may be too slight in amount to affect greatly either the capacity or the efficiency at a constant firing rate. At constant firing rate the soot has a large effect on the flue gas temperature.

## Ceiling Insulation and Comfort

Report BMS52 of the Building Materials and Structures series of the National Bureau of Standards is entitled Effect of Ceiling Insulation Upon Summer Comfort, by Thomas D. Phillips. It is 10 pages in length and can be had from the Superintendent of Documents, Washington, D. C. for 10c.

This investigation deals with the effect of insulation in limiting the temperature rise of the rooms in the upper story of a building with a flat roof. For test purposes a structure was built on the roof of one of the buildings at the National Bureau of Standards. This structure has a "flat" (slightly sloping) roof, below which is a low attic separated from the room below by a ceiling of plasterboard. Various types of insulation were installed just above this ceiling to insulate it from the attic space. The temperature of the ceiling in the room below was measured, and the effect of the insulation in limiting the rise in the temperature of the ceiling was determined.

The results show that a lath and plaster or equivalent ceiling

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exposed directly to the heat of the attic will be so hot on warm summer days as to add materially to the discomfort of persons in the room below. Even a moderate amount of insulation will make the room much more comfortable.

### Specifications for Surface Condensers

The Heat Exchange Institute, 90 West St., New York, N. Y., has issued an 8 p. 8½ x 11 in. booklet of Typical Specifications for Surface Condensers and Auxiliaries for Turbine Service which is available from the institute at 25c per copy.

This publication is designed as a guide to purchasers of surface condensers. The "typical specifications" are similar in form to a check list so as to insure that complete information is supplied by purchasers to manufacturers. The use of the typical specifications will enable the manufacturers efficiently to design a surface condenser to meet the specific requirements of the purchasers. Its use will result in the saving of considerable time which is usually lost when pertinent information has not been supplied by the purchasers, according to the institute.

### Radiant Temperatures from Lighting Systems

A paper on Radiant Temperatures from Lighting Systems with Comfort Correlations was presented by Howard M. Sharp, Manager, Lighting Bureau, Buffalo, Niagara & Eastern Power Corp., before the 34th annual convention of the Illuminating Engineering Society. In the paper the author described a practical method of ascertaining the mean radiant temperature of lighting systems in common use in commercial and industrial interiors, outlined the test procedure and recorded results obtained from investigations under actual working conditions. Psychrometric data and comfort sensation of occupants were reported in an attempt to uncover possible correlation.

In conclusion, the author stated "that much remains to be

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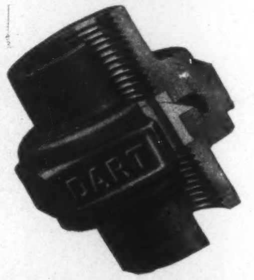

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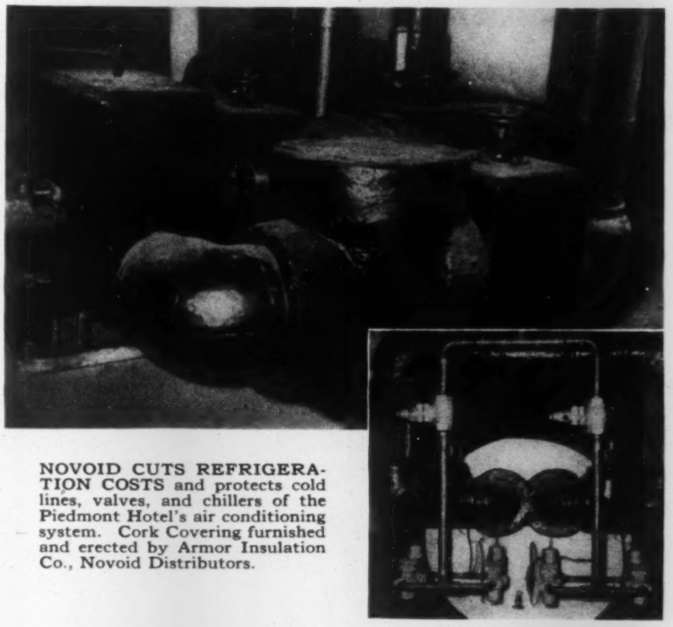

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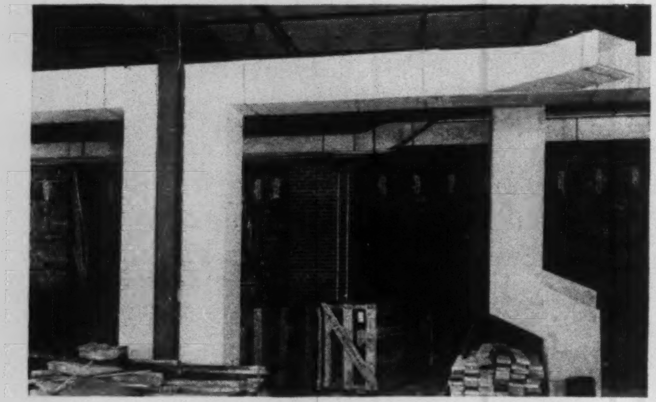

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done before all factors which influence comfort are explored and brought into workable form. The lighting profession can contribute much to this advancement of knowledge, and should do so in the interest of wider use of desirable illumination. The present investigation would seem to extend our horizons enough to show that of the various factors which influence thermal comfort sensations, lighting plays a minor rôle. However, it would seem desirable to extend radiant studies along the lines of widespread field surveys, supplemented by a more exact analysis of all forms of light utilization under identical, controlled, reproducible conditions, so as to provide data by means of which field and laboratory deviations could be segregated for further study. We can then look forward to a time when, with all factors fairly well understood, adjustments can be made in each to the end that people can be provided with an environment producing the maximum of balanced comfort, efficiency and harmony."

## Recent Trade Literature

**For your convenience in obtaining copies of these bulletins, see coupon on page 118. If you write direct to the manufacturer, describe carefully what literature you want, as the number given first in each item is for use only when sending your request to HEATING, PIPING AND AIR CONDITIONING.**

No. 3656. AIR AND VACUUM VALVES: Dole Valve Co., 1901-1941 Carroll Ave., Chicago, Ill. 8 p. bulletin (CPE-1097) listing the manufacturer's line of air and vacuum valves—including "Vari-Vent" valves—grouped according to their applications for automatic fired jobs, hand fired jobs, for vacuumizing, etc.

No. 3657. AIR DISTRIBUTION DEVICES: Plandaire, Inc., 3223 Kennett Square, Pittsburgh, Pa. Looseleaf catalog on

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"Kno-Draft" air distribution devices describing their features, giving mounting details and dimension tables, selection tables and instructions for their use, specifications and installation information. Also, a 4 p. pamphlet on the "Model SR" combination supply and return high velocity air distribution terminal.

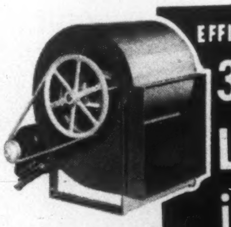
No. 3658. AMMONIA COMPRESSORS: Frick Co., Waynesboro, Pa. 16 p. bulletin (112-G) on enclosed type ammonia compressors with information on their general features, their applications (including air conditioning), the principles of refrigeration, construction details, control, lubrication, belt drives, and dimensional drawings.

No. 3659. BALANCING MACHINE: Gisholt Machine Co., 1387 E. Washington Ave., Madison, Wis. Performance data sheets (55 and 59) giving case studies of typical examples of static and dynamic balancing on "Dynetric" balancing machines, one covering industrial ventilating equipment and the other home ventilating fans. A detailed description of the procedure for locating, measuring and correcting the unbalance in these fans is given.

No. 3660. BLOWER WHEELS: Advance Aluminum Castings Corp., 2742 W. 36th Pl., Chicago, Ill. 80 p. catalog illustrating complete line of "Castalu" blower wheels with performance charts and tables showing capacities of different size fans at various speeds and static pressures based on tests in accordance with the rules of the National Association of Fan Manufacturers. Of particular interest is a new scroll layout for use in accurately laying out the housing for any size fan; all dimensions shown on the layout are ratios of fan diameters.

No. 3661. BLOWER WHEELS: Morrison Products, Inc., E. 168th and Waterloo Rd., Cleveland, Ohio. 4 p. bulletin on "Airstream" blower wheels, illustrating their construction features.

No. 3662. BOILER FEEDWATER TREATMENT: Permutit Co., 330 W. 42nd St., New York, N. Y. Bulletin describing new process for removing silica from boiler feedwater to



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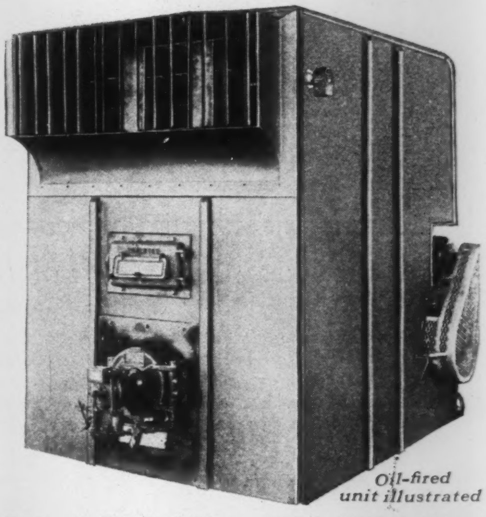

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No. 3663. CO$_2$ INDICATORS: Bacharach Industrial Instrument Co., 7000 Bennett St., Pittsburgh, Pa. 4 p. bulletin (337) on "Fyrite" CO$_2$ indicators, describing features and how they work.

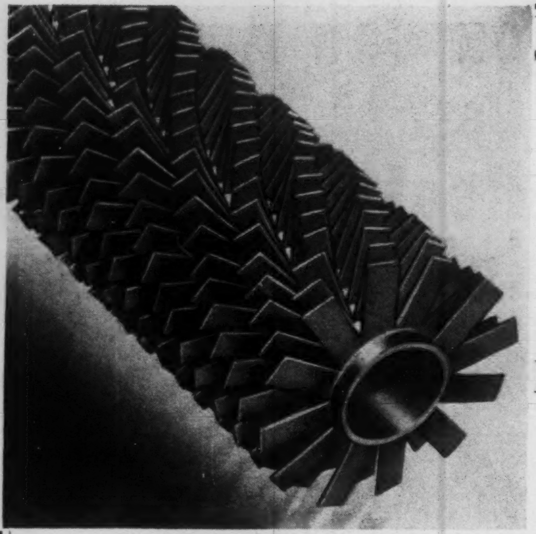
No. 3664. CONTROLS: Minneapolis-Honeywell Regulator Co., 2701 Fourth Ave., S., Minneapolis, Minn. 16 p. booklet entitled A Heated Question Answered which tells a straightforward story of fuel savings based on various tests by authorities and of interest to every building owner. The manufacturer's "Chronotherm" thermostat is featured.

No. 3665. COOLING TOWERS: Binks Mfg. Co., 3114 Carroll Ave., Chicago, Ill. 4 p. bulletin (400) on small series self-contained horizontal type induced draft cooling towers recommended by the maker for small and medium capacity self-contained air conditioners and similar equipment. A capacity table and specifications are included.

No. 3666. COPPER IN AIR CONDITIONING: Copper & Brass Research Association, 420 Lexington Ave., New York, N. Y. Bulletin (111) including an article on how the physical properties of copper and brass are valuable in air conditioning work and giving a description of a number of installations and the copper and brass equipment used in them.

No. 3667. EXHAUST FANS: Chelsea Fan & Blower Co., Inc., 370 W. 15th St., New York, N. Y. 1 p. bulletin illustrating belt drive exhaust fans, available with or without penthouse, one of the manufacturer's line of exhaust fans ranging in size from 12 to 72 in.

No. 3668. EXTENDED SURFACE TUBING: Tilco-Fin Inc., 58 Second Ave., Brooklyn, N. Y. 4 p. bulletin on extended surface tubing illustrating laboratory tests and showing some typical uses—including heating and cooling surface, high pressure heater coils, direct expansion coils, etc.



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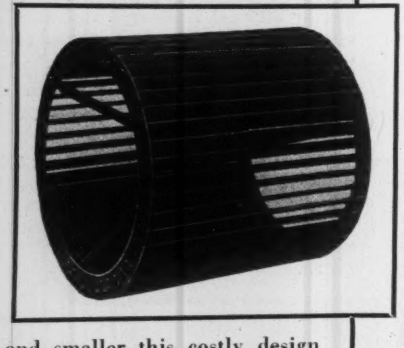

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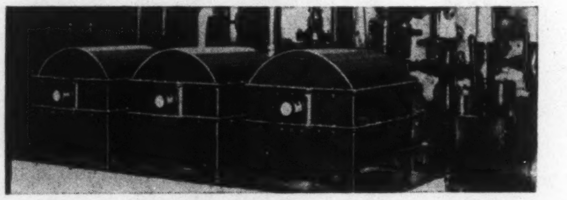

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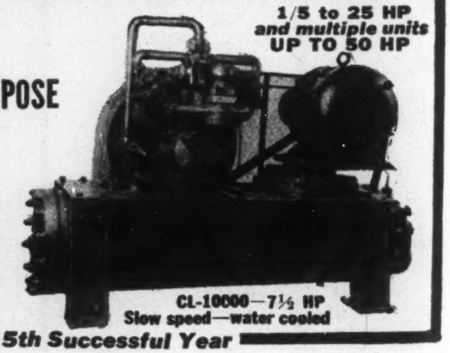

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No. 3669. FANS: National Association of Fan Manufacturers, 5-208 General Motors Bldg., Detroit, Mich. 16 p. pictorial booklet entitled The Magic of Fresh Air and Electricity showing applications of ventilating equipment for use in industry, commercial establishments and the home.

No. 3670. GLYCOLS: Carbide & Carbon Chemicals Corp., 30 E. 42nd St., New York, N. Y. Folder (No. 2) on glycols, one of a series presenting properties, uses and possibilities of organic chemical families. Among the uses of glycols are antifreeze solutions, heat transfer media and others.

No. 3671. HEATING COILS: Fedders Mfg. Co., Inc., 57 Tonawanda St., Buffalo, N. Y. Set of four "Time Saver" charts for quick and accurate figuring of temperature rises for various operating conditions for "Type K" heating coils. These charts have been reprinted from the manufacturer's latest catalog covering the complete line of these coils.

No. 3672. HOT WATER SUPPLY HEATERS: Taco Heaters, Inc., 342 Madison Ave., New York, N. Y. 16 p. catalog (A-99) on heaters for hot water supply showing applications, giving information on construction and installation, and presenting tables of capacities and dimensions.

No. 3673. LIQUID LEVEL CONTROLLERS: Cochrane Corp., 3161 N. 17th St., Philadelphia, Pa. 10 p. bulletin (2939) describing in detail five different methods of liquid level control with wide application in the power and process fields. A discussion of operation and advantages of each type simplify proper selection from tabulated data that include operating characteristics and list prices.

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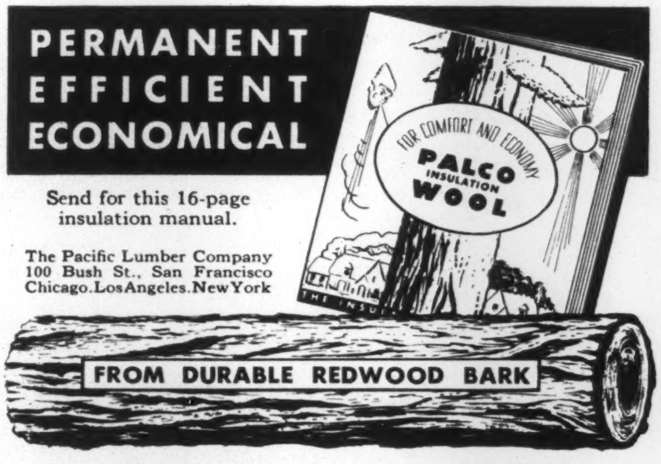

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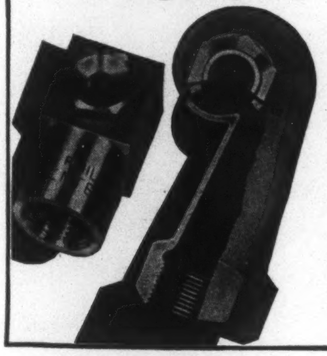

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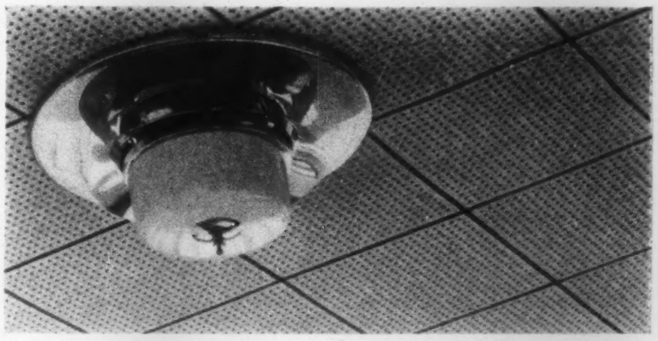

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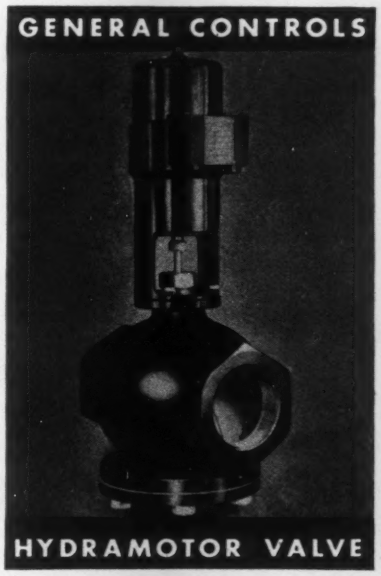

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